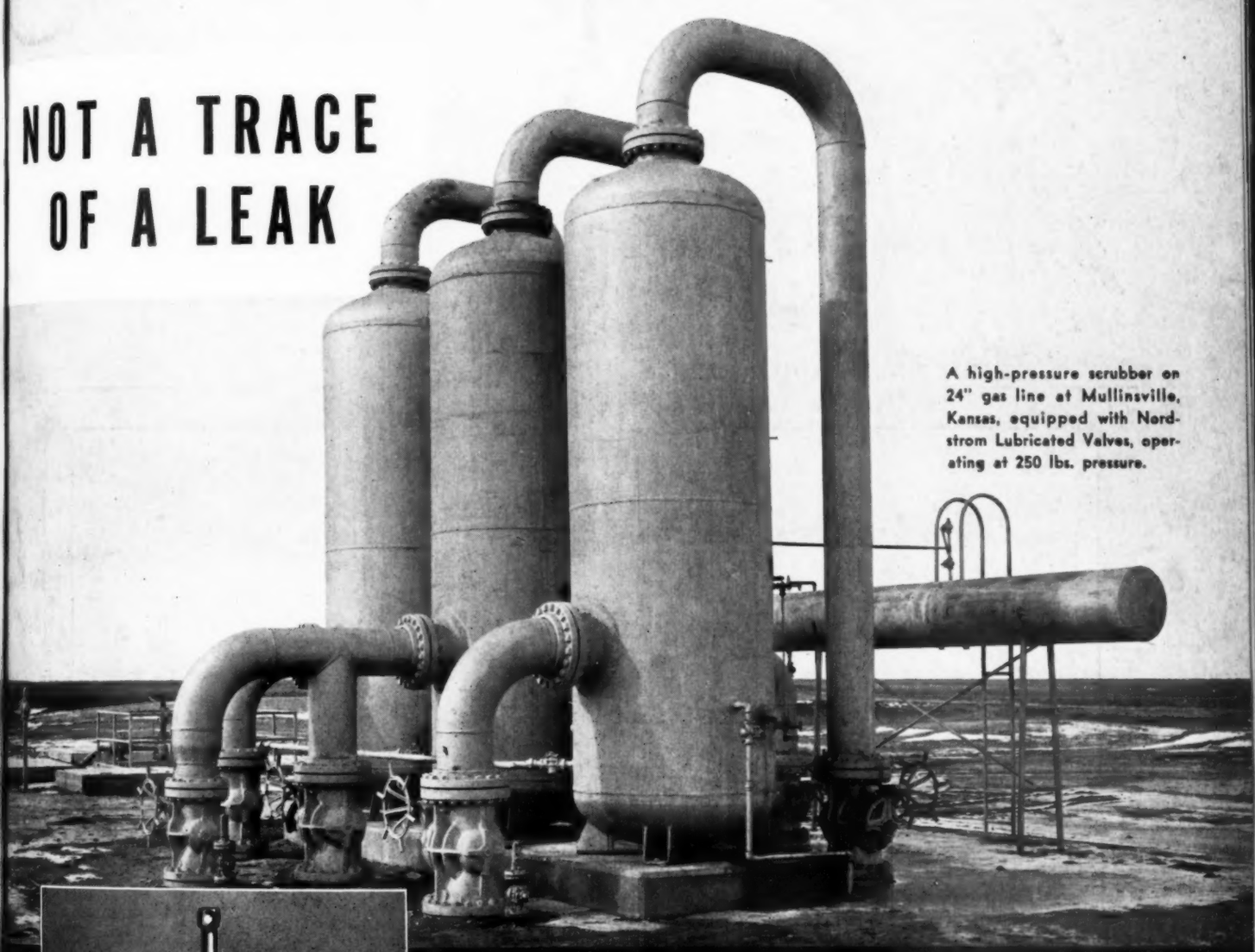
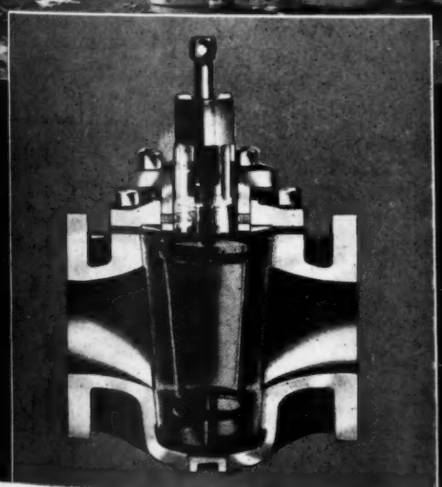
NOT A TRACE OF A LEAK



A high-pressure scrubber on 24" gas line at Mullinsville, Kansas, equipped with Nordstrom Lubricated Valves, operating at 250 lbs. pressure.



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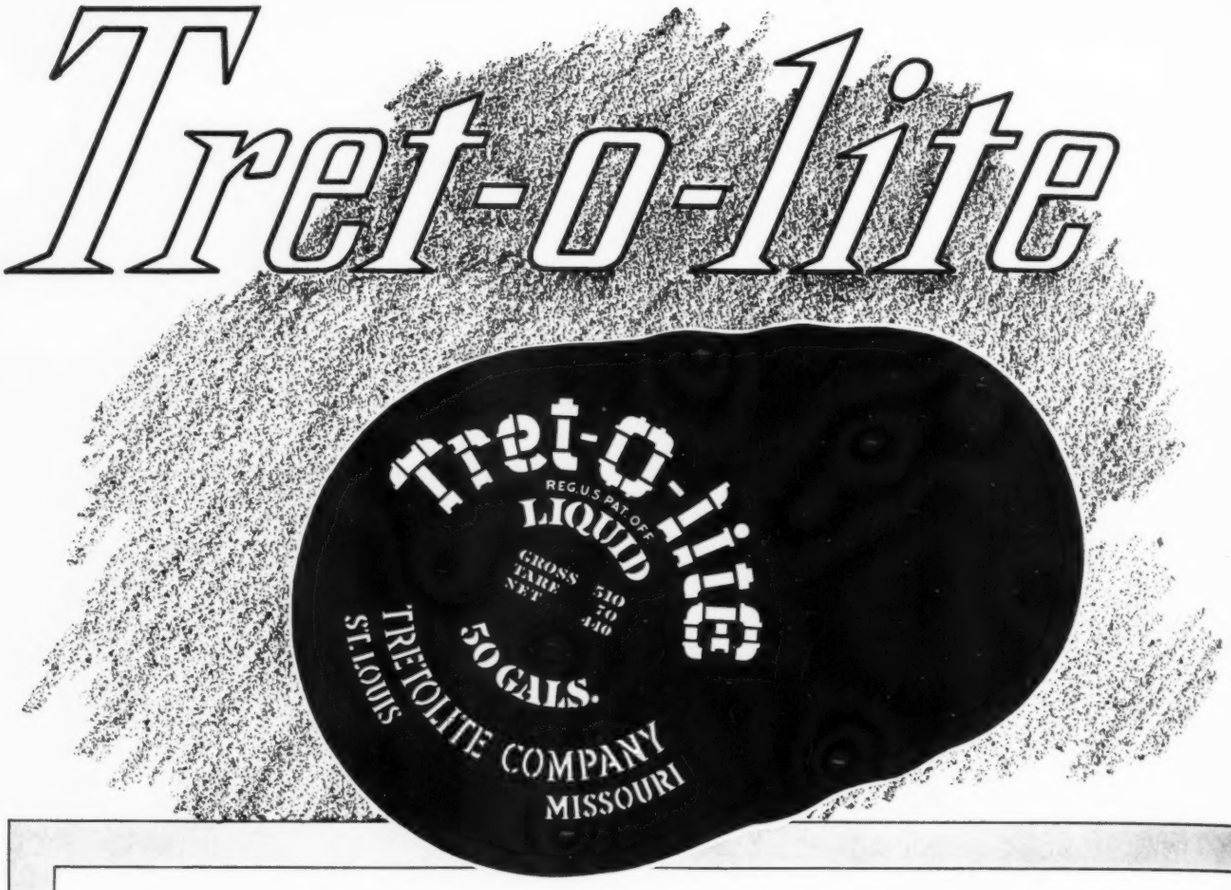

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Meetings

- California Natural Gasoline Association—September 2, Richfield Building, Los Angeles, California.
- American Chemical Society—September 6, 7, 8, 9, and 10, Rochester, New York.
- Pacific Oil Show and Black Gold Festival—September 16, 17, 18, and 19, Taft, California.
- American Gas Association, 19th Annual Meeting—September 27, 28, 29, 30, and October 1, Cleveland, Ohio.
- Society of Automotive Engineers, Fuels and Lubricants Regional Meeting—September 30 and October 1, Tulsa, Oklahoma.
- Oil-World Exposition, Inc.—October 11, 12, 13, 14, 15, and 16, Houston, Texas.
- Independent Petroleum Association of America, Annual Meeting—October 14, 15, and 16, Houston, Texas.
- American Asociation of Petroleum Geologists, Mid-Year Meeting—October 14, 15, and 16, William Penn Hotel, Pittsburgh, Pennsylvania.
- American Welding Society, 18th Annual Meeting and Welding Exposition—October 18, 19, 20, 21, and 22, Atlantic City, New Jersey.
- Mid-Continent Oil and Gas Association of Texas, Annual Convention—October 29, and 30, Dallas, Texas.
- American Petroleum Institute, 18th Annual Meeting—November 9, 10, 11, and 12, Stevens Hotel, Chicago, Illinois.
- International Petroleum Exposition—May 14, 15, 16, 17, 18, 19, 20, and 21, 1938, Tulsa, Oklahoma.

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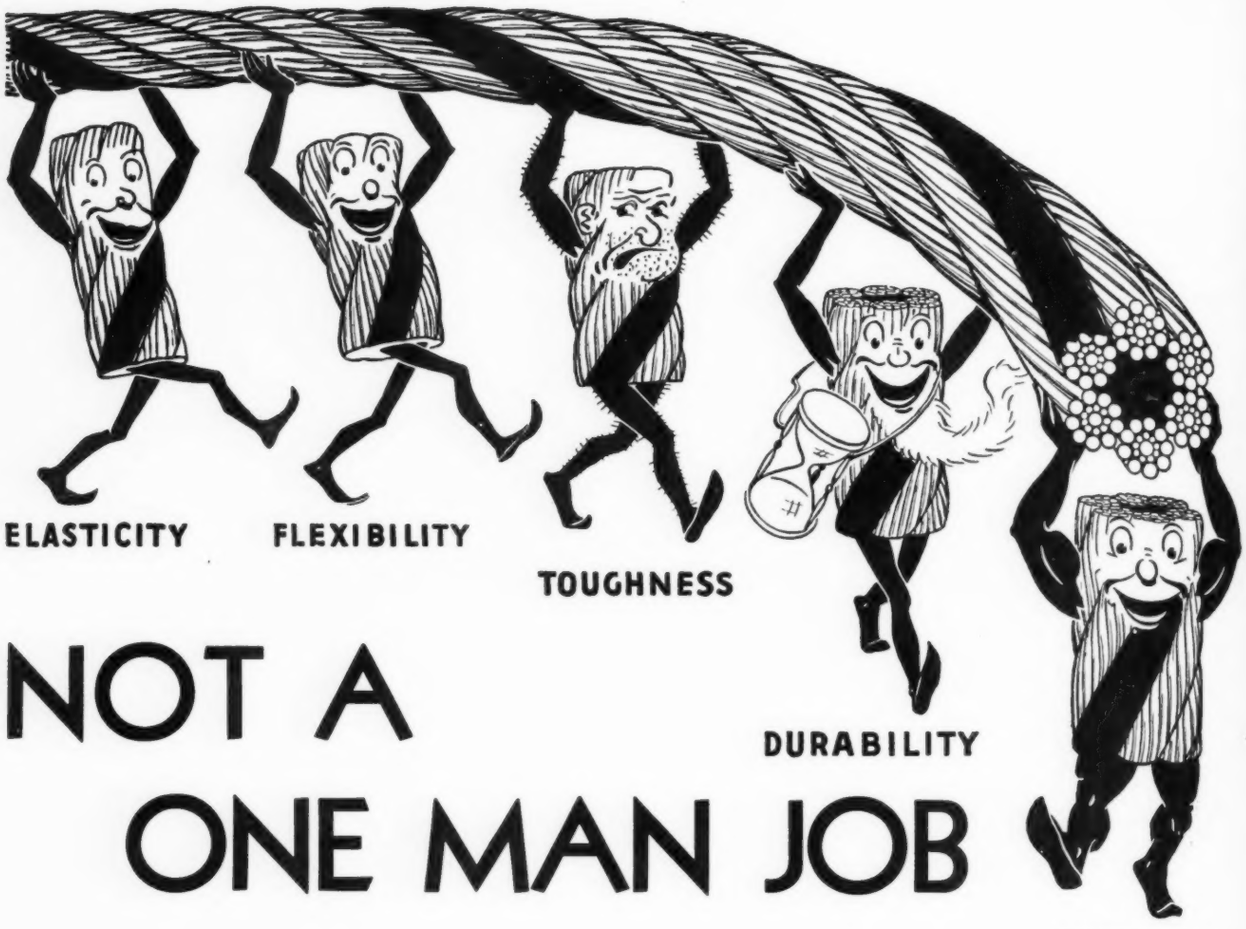

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The Course of Oil

By K. C. SCLATER

Petroleum In South America

Fundamental differences of climate and country influence the field methods employed in drilling for and producing petroleum and natural gas. This influence extends also to transportation methods and to plant practices involved in converting the crude into marketable products. Particularly is this true in South America, a leader today in world petroleum production. On this continent the occurrence of petroleum deposits is quite varied and as a result, the field practices employed cover a wide variety of technique. A good example is the petroleum development operations in Maracaibo Lake. In contrast there is the development of petroleum deposits in difficultly accessible districts in the interior such as those in parts of Colombia, Venezuela, and Argentina. A description of these operations is interesting and instructive. Many of the methods are the most advanced and efficient of their kind. Some of them have been pioneered in that country. On the whole, the methods employed follow the basic principles of sound engineering practice. These methods and practical details pertaining thereto are covered in a survey of the petroleum industry in South America, including Trinidad, in a special section of this issue.

Wildcatting And Depletion Allowance

There is deep indignation among many in the industry over what is construed as an effort of the Secretary of the Treasury to embarrass the oil industry by grouping depletion with violation of the tax laws. Quite aside from the inference, however, it is believed that a reduction in percentage depletion for oil and gas wells, considered from any angle, is much more likely to lead to harm than good. In all probability it would curtail wildcatting activity, the result of which would be a falling off in the discovery of new fields and a consequent shrinkage in national wealth. Such shrinkage might conceivably lead to a serious loss of government revenue—a loss much greater to the government than the revenue that would be derived from a reduction in depletion allowance.

Wildcatting, particularly at the present time, is a vital activity that should be encouraged. As long as the threat of a reduction in depletion allowance hangs over the industry, prospecting activities are bound to be adversely affected.

Exemplary Reservoir Control

Scientific reservoir control as applied in the Masjid-i-Sulaiman field, Iran, was commented on in this column in March, 1933. Further information available on this field outlines some of the remarkable results that continue to be obtained. Producing operations are carried on with a high degree of efficiency—an efficiency that speaks volumes for scientific reservoir control. The field is operated solely by one company, the Anglo-Iranian Oil Company, a very favorable circumstance and one that makes it a unit operation. As such it is making a substantial contribution to the technique of producing oil by applying methods that ensure the optimum utilization of reservoir energy. Although the field has been producing for 25 years, there are no wells on the pump or on artificial gas-lift. The pressure drop in the reservoir is five pounds against a production of some 95 million barrels of oil, or approximately five hundredths of a pound per million barrels of oil produced. The producing formation is massive fissured limestone from 300 to 1000 feet in thickness. Gas, oil, and water are present in the reservoir. Both the water-oil and gas-oil levels are maintained uniform throughout the reservoir, and are followed by means of observation wells. Injection of gas and fractions of the oil at different sections in the reservoir, and also distribution of production from the reservoir are varied according to the results observed. Maximum utilization of energy for lifting, as distinct from conservation of gas energy in the reservoir, is regarded as of great importance in this field, in order that wells at highest surface elevations be kept flowing in the face of diminishing reservoir pressure. As a further means of conserving energy, all wells are produced through the casing. The rate of production is adjusted so that slippage losses will be small. The flow-head pressure-production curve shows that at any given flowing pressure two rates of production are possible. At the lower rate of flow the energy lost is principally due to slippage, friction being negligible. At the higher rate of flow, the energy loss is in friction but slippage loss is negligible. The wells therefore are produced at the higher rate of flow because of the smaller energy loss.

Conditions in this field are ideal for producing under strict scientific control because of the absence of competitive conditions such as obtain in oil-fields of the United States. This is scientific control of the kind that engineers and technicians dream of but are denied the opportunity of putting into practice. The significance of these operations lies in the great advances that have been made and the remarkable results obtained. Even flexibility in meeting fluctuating market demand for products is provided by topping in the field a proportion of the crude, fractions not needed being returned to the reservoir. Methods of operation in this field definitely remove scientific control far from the realm of theory by applying it to highly practical ends. What has been and is being accomplished in this field sets the standard for scientific reservoir control. What has been accomplished in Masjid-i-Sulaiman field could be accomplished in many other fields were more sympathetic understanding and proper cooperation available to the capable technical man.

« « HIGHLIGHTS IN OILDOM » »

Kansas Adopts New Rules for Taking Potentials

The Kansas Corporation Commission has established new rules and regulations for taking well potentials, having adopted a composite withdrawal decline curve in determining the potentials of oil wells following initial physical tests. This is the first state to adopt such a policy.

The commission believes that establishing potentials by taking physical tests of wells at intervals of nine months, then adjusting the potentials on a decline curve, will promote conservation. Premature encroachment of water in producing wells is thought to have been the result of taking potentials too frequently and of too long duration.

The Commission has stated also that in its opinion the composite withdrawal decline curve based on actual experience of wells, with adjustments based on the spacing of wells, and adjustment every nine months based on physical tests, reasonably reflects the potential of a well and prevents inequitable taking from a common source of supply.

●

Michigan Crude Oil Prices Cut 15 Cents

An increase in production in the Buckeye field of Michigan, and local conditions in the West Branch, Arenac, Porter, and Crystal areas, have resulted in a 15-cent per bbl. reduction in the price of crude oil. The new price level has been announced by the Pure Oil Company, Simrall Pipe Line Company, and the McClanahan-Leonard Pipe Line Company.

The quotation for West Branch and Arenac oil is $1.09, Buckeye oil $1.24½, and Mt. Pleasant, Porter, and Crystal crudes $1.27 a barrel.

●

Venezuela's Output of Petroleum Products Is Increasing

A report from the office of the American commercial attache at Caracas, made public by the United States Department of Commerce, states that production of petroleum in Venezuela the first five months of this year totaled 10,046,295 metric tons compared with 9,563,810 metric tons in the corresponding period of 1936.

Exports of petroleum and petroleum products from Venezuela during the five-month period this year was 9,036,176 metric tons, including 6,649 tons of gasoline, as compared with 9,008,566 tons during the first five months of last year. Exports of gasoline for the January-May period of 1936 is not a matter of record.

●

10-Acre Spacing for Arkansas Rodessa Extension

An order has been promulgated by the Arkansas Board of Conservation governing the Miller County extension of the Rodessa field, leaving the existing 10-acre well-spacing rule in effect, but ordering that 50 percent of the total daily field allowable shall be based 50 percent on acreage and 50 percent on bottom-hole pressure. The board has reserved the right, however, to allocate production on the basis of bottom-hole pressure, acreage, and gas-oil ratio. The order also states that in no instance shall less than 40 acres be nominated for a single well, and provision has been made for drilling additional wells on tracts of more than ten acres and not more than 40 acres where wells already are drilling.

●

Proposed Cuban Legislation on Oil Concessions

A bill recently was introduced in the legislative body of Cuba entitled "National Petroleum Law," providing that all petroleum products in the Republic be considered as government property, and that concessions to explore and develop such deposits be granted by the government.

The bill provides that concessions be granted only to Cuban citizens or organizations, aliens being permitted to operate only through subsidiary companies organized in Cuba. Aliens holding concessions at the time the measure becomes law would be exempt from this requirement, however.

Under the provisions of the bill concessions would not convey ownership of petroleum deposits, but only the right to explore and develop. They would be valid for a period of two years and would cover not more than 70,000 hectares each.

Except for concessions of less than 500 hectares granted prior to June 1, 1937, those obtaining development concessions would be required to develop the area covered thereby on penalty of cancellations of the concession. The bill requires that during the first year at least one well must be opened for every 1000 hectares, or fraction thereof, in the concession.

●

Calif. Passes New Law Governing State-Owned Lands

The O'Donnell Act, providing for the development of state-owned oil lands at Huntington Beach, California, has passed the State Legislature, received the approval of the governor, and thus has become a law. It becomes effective August 27. The new law provides for competitive bidding on 11 parcels of land, comprising approximately 120 acres each, in the Huntington Beach area. The O'Donnell Act will supersede the Olson Law, passed at the recent session of the legislature.

The principal differences in the O'Donnel Act and the Olson Law are that the former calls for minimum bids of 30 percent royalty on production of 200 bbl. to 999 bbl., 40 percent on 1000 to 1999 bbl., and 50 percent on 2000 bbl. and more. The Olson Law requires a minimum royalty of 30 percent flat on production of 200 bbl. or more. The Olson measure provides for not less than ten wells per parcel, the O'Donnell Act for not less than five. The former prohibits the drilling of more than one parcel by any one company or interest, but under the O'Donnell Act any number of parcels may be drilled by one company or interest. Several other differences exist also, relative to the amount of bond required before operations can begin, the administrative body, etc.

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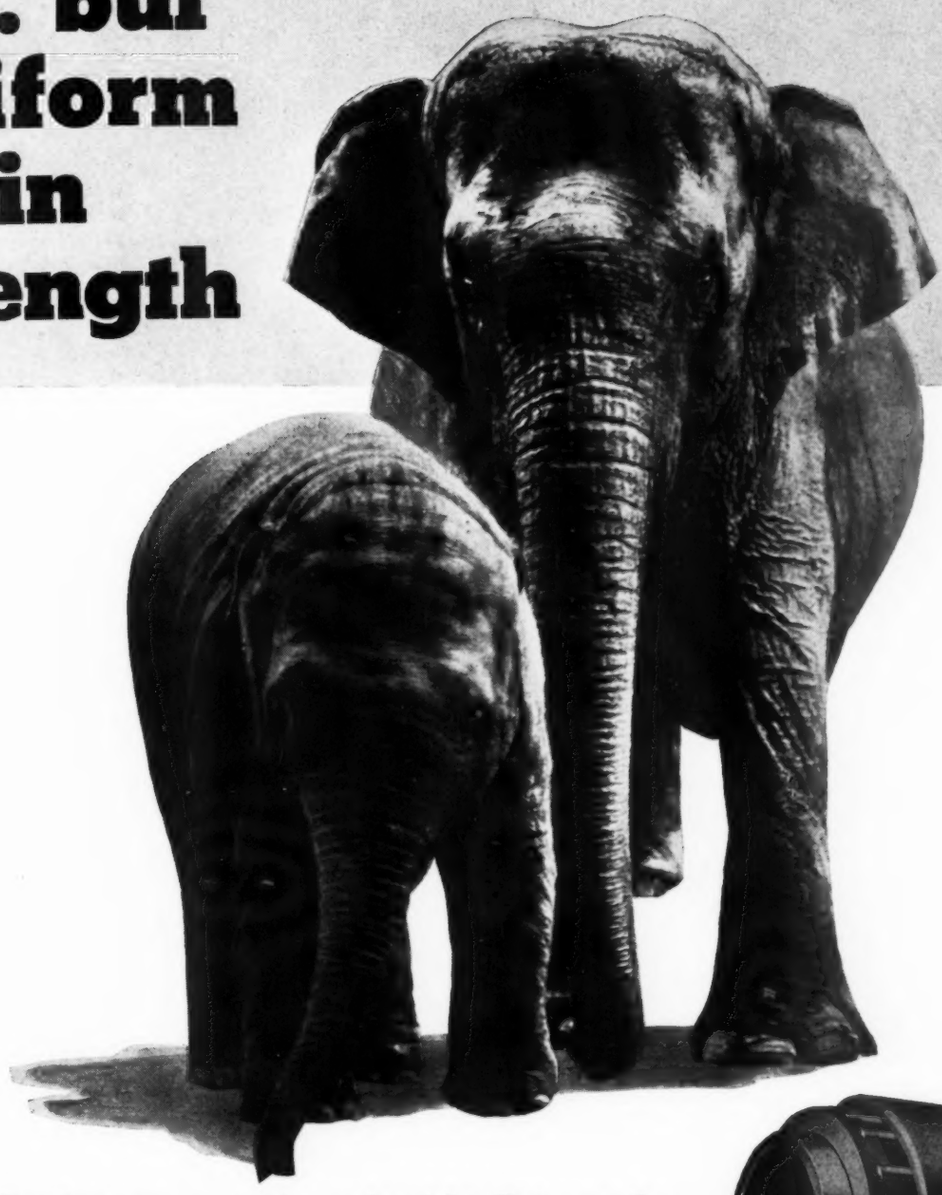

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Progress of Major Pipe Line Work

THE Shell Petroleum Corporation has announced plans for the construction of a 250-mile 8-in. pipe line from its refinery at Roxana, Illinois, to Indianapolis, Indiana. Work is expected to begin within 30 to 45 days. The project will involve an expenditure of $3,000,000.

Although the line will be utilized primarily for the movement of gasoline from Roxana to Indianapolis, it also may be employed to handle crude oil from the active Illinois fields.

At the present time Shell is shipping gasoline and other refined products from its plant by tank car and also by barge on the Ohio River. The new line will facilitate their movement. It is expected to be completed and in operation within a period of six months.

●

Another major gasoline pipe line to extend from Mid-Continent fields to a terminus in Iowa has been announced by a group of independent refining companies. The length of the line will be 650 miles.

The line will have its origin at Grandfield, Oklahoma, will pass through Beckett, Cyril, and Cushing, Oklahoma, and extend into Kansas, Nebraska, and Iowa.

Those involved in the project are Anderson-Prichard Oil Corporation, Oklahoma City, who own a refinery at Cyril; Rock Island Refining Company, who have a plant at Beckett; Cushing Refining and Gasoline Company, who have a refinery at Cushing, and the Bell Oil and Refining Company, Tulsa, who have a refinery at Grandfield.

Ford, Bacon and Davis, Inc., pipe line contractors, have started a survey of the line.

Anderson-Prichard Oil Corporation, who are part owners of a refinery at Colorado, Texas, are considering laying an extension from Grandfield to that point.

●

Construction of a 160-mile pipe line system in South Louisiana by the Standard Oil Company of Louisiana, is one of the major pipe line projects to be announced within recent weeks. The work will involve an expenditure of $1,500,000 and will provide needed outlet for several coastal Louisiana fields.

The line will extend from the Standard's tank farm at Baton Rouge, on the west bank of the Mississippi River, to the Roanoke field near Jennings.

Existing plans are for the laying of 25 miles of 10-in. pipe, 63 miles of 8-in., and 72 miles of 6-inch. Branch lines will run to the New Iberia and Jeanerette fields.

The laying of this line will give the Baton Rouge refinery of the Standard Oil Company of Louisiana its first direct line to South Louisiana fields.

●

The Republic Pipe Line Company soon will begin construction of a pipe line from Benevides, Texas, to Corpus Christi where the company has a terminal. The distance covered will be 70 miles. The company now has gathering systems in the Sweden and North Sweden fields, which are connected to loading racks at Sweden and Benevides, the crude oil being shipped by tank car. The new line will connect with these gathering systems.

●

Another South Texas pipe line construction project has been initiated by the Duval Pipe Line Company, a Benedum and Trees concern. A 75-mile 6-in. line will be laid from Corpus Christi to the Sweden field. The order for the pipe already has been placed. The company and its affiliated companies have several thousand acres under lease in the North Sweden and the old Sweden fields.

●

The Oklahoma Natural Gas Company has completed the laying of a new line from Enid, Oklahoma, to the Marshall, Lovell, and Crescent pools of Logan County. The line is 10 in. from Enid to Marshall, and 8 in. from Marshall to Lovell and Crescent. The length of the line is 60 miles.

●

The San Francisco office of H. C. Price Company has announced that it has been awarded a contract by the Pacific Gas and Electric Company for electric welding 44 miles of 10-in. and 12-in. pipe line from the Rio Vista field to Dawson, Dixon, and Napa Junction, California; also 12 miles of 8-in. from Davis to Woodland, California.

●

The West Oak Gasoline Company recently awarded a contract to Frenchies Welding Works for the welding of a 14-mile 10-in. gas line in the vicinity of Sayre, Oklahoma. The stovepipe method of construction is being employed and welding is by the oxy-acetylene Lindeweld method.

●

Naph-Sol Refining and Pipe Line Company is constructing a 21-mile 4-in. line from the Buckeye field of Gladwin County, Michigan, south to Coleman. From the latter point shipments will be by tank car.

Capacity of the new line will be 6000 bbl. daily and crude will be taken principally from the Rex Oil Company, an affiliate.

●

Southern Liberty Pipe Line Company, subsidiary of the American Liberty Oil Company, is laying a 12-mile 6-in. line from its existing facilities terminating in the James Davenport Survey of Cass County, Texas, to the recently-opened Lodi extension of the Rodessa area. The new line will provide an outlet for five wells, the production from which has had to be trucked to a railroad loading rack near Lodi.

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Latest Activities In The Oil Fields

FINDING of the Strawn sand in Montague County, North Texas, is expected to open a new deep field in that area. In Lupton, Wilson and Ligon's wildcat, four miles west of Bowie, the Strawn sand was found at a depth of 3928 ft., and 12 ft. of saturated sand was drilled, and pipe set to test.

•

Opening six to eight miles of new territory, R. M. Ragsdale et al.'s No. 1 John Taber, 20 miles north of Brownwood, Texas, has been brought in flowing initially 750 bbl. of 43-gravity oil daily. Production is from the Ranger lime at a total depth of 2461 feet.

•

Early this month the Rodessa field was extended one-half mile to the northwest. The Bay Oil Corporation completed its No. 1 Cobb and No. 1 W. B. Parker, both in the George Crowder Survey, just across the line into Cass County. Production is from the Mitchell sand, the former well producing 30 bbl. an hour through ½-in. tubing choke, and the latter 18 bbl. an hour through the same size tubing choke.

•

A new strike has been made in western Kansas by the Atlantic Refining Company, the Empire Oil and Refining Company, and the Skelly Oil Company with their No. 1 Runyan, in the southwest of the northwest of the northeast of 11-27-13w, in Pratt County. In the Simpson sand at a total depth of 4310 ft. the test had 1500 ft. of oil in the hole, indicating a good well.

•

David Lide, George Greer et al. have found a new gas reserve for north Louisiana with their No. 1 Causey, in 32-19-2, in wildcat territory, Lincoln Parish. On a test at a depth of 5320 ft. the well had an estimated flow of 50,000,000 cu. ft. of gas daily from the basal Glen Rose formation.

Successful completion by the Ohio Oil Company's No. 1 Arbuthnot in Richland County, Illinois, has been the cause of great excitement in the Illinois Basin area. The well is producing from the McCloskey sand at a total depth of 2988 ft., and initial production was reported to be 2500 bbl. daily.

•

A new pool has been discovered in the Los Angeles Basin of California, between Long Beach and Dominguez. The Hilldow Oil Company's No. 1 A.M.E.B. Company was brought in recently producing initially 960 bbl. of oil of 24.2 gravity, cutting a small amount of water and mud. Production was through 1-in. choke and at a total depth of 4038 feet. Pressure on the tubing was 20 lb. and on the casing 150 pounds. Operators believe the well to be producing from the upper Alamitos zone.

•

Impetus has been given development of the deeper sand in the Rosecrans field of Los Angeles County, California, by the successful completion of Universal Consolidated Oil Company's No. 1 Trust at a total depth of 7580 ft., producing 400 bbl. of oil of 33.9 gravity daily. Union Oil Company's No. 16 Rosecrans is producing 505 bbl. of oil of 33.2 gravity from a total depth of 7560 feet. The first deep producer in the field was Barnsdall Oil Corporation's No. 10 O'Dea, producing 700 bbl. daily at a total depth of 7664 feet.

•

No. 1 McTaggart of E. H. Linaberry, a wildcat in Adams Township, Arenac County, Michigan, has been completed in the Traverse lime as a 40-bbl. pumper. The new well is nine miles south and six miles west of the Clayton pool in the same county.

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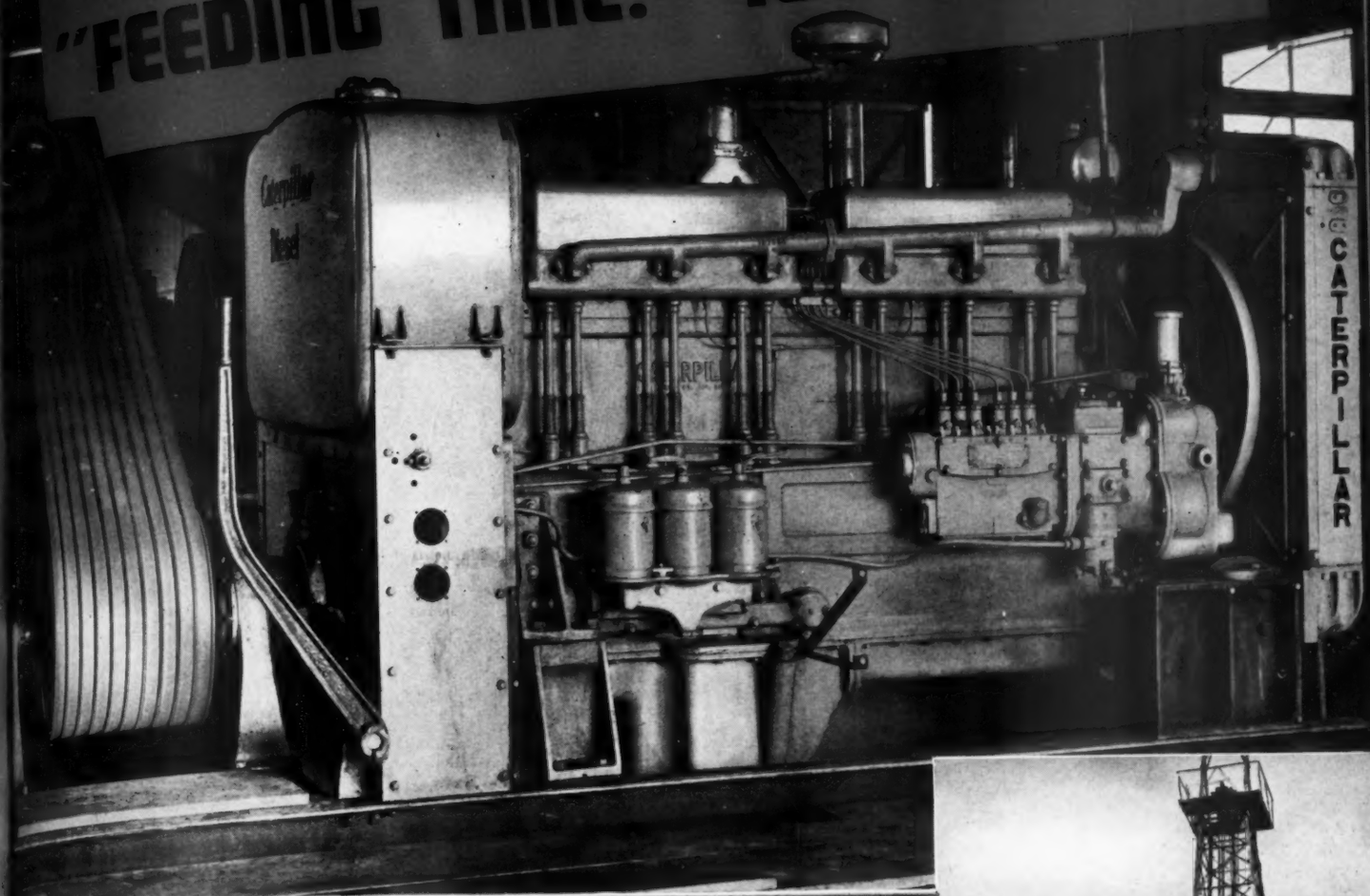
Colorado	1.12-1.18
New Mexico	.78-1.08
Texas	
North Central	.96-1.20
Panhandle	.91-1.08
West Texas	.78-1.08
Gulf Coast	.95-1.41
Darst Creek	1.09
East Texas	1.35
Talco	.73
Kansas	.98-1.30
Oklahoma	.98-1.30
Arkansas	.90
Louisiana	
Rodessa	$ .91.1.25
Gulf Coast	.84-1.41
North Louisiana	.90-1.22
Illinois	1.35
Kentucky	1.40
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.27
Pennsylvania	
Bradford	2.82
Southwest	2.57
Eureka	2.52
Buckeye	2.37
Corning	1.42
West Virginia	1.67
Canada	2.10-2.17

DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.
(Figures in Barrels)

	B. of M. Dept. of Int. Calculations (July)	Week Ended July 31 1937	Week Ended July 3 1937	Week Ended Aug. 1 1936
Oklahoma	629,700	637,650	619,600	541,100
Kansas	195,600	207,150	193,000	156,000
Panhandle Texas		90,950	80,500	61,950
North Texas		73,200	72,600	59,850
West Central Texas		33,600	33,650	26,300
West Texas		205,950	200,600	180,250
East Central Texas		125,300	123,750	57,650
East Texas		470,800	466,550	429,100
Southwest Texas		238,700	236,450	165,500
Coastal Texas		205,500	202,500	181,700
TOTAL TEXAS	1,375,100	1,433,000	1,416,600	1,152,300
North Louisiana		91,850	88,300	84,150
Coastal Louisiana		172,200	173,050	147,750
TOTAL LA.	253,000	264,050	261,350	231,900
Arkansas	28,400	28,700	28,350	29,650
Eastern	122,100	122,200	123,550	113,200
Michigan	39,800	45,100	43,100	35,500
Wyoming	52,900	56,700	48,900	39,150
Montana	16,200	18,300	17,200	15,700
Colorado	4,700	5,000	4,300	4,650
New Mexico	100,800	114,450	114,600	74,150
TOTAL EAST OF CALIF.	2,818,300	2,932,300	2,870,550	2,393,300
California	605,500	659,600	655,100	554,700
TOTAL U. S.	3,423,800	3,591,900	3,525,650	2,948,000

"FEEDING TIME:" 15 MINUTES



▲ D13000 engine with Vee belt to friction reverse clutch and flat belt to band wheel

A quarter-hour for servicing, then "back to the grind"—23¾ hours a day.... That's the record this 125-hp. Diesel Engine hung up for forty-five consecutive days on a Russell County, Kansas, operation by the Parker Drilling Company. With no repairs or overhauling of any kind, it next went on similar continuous work on the well shown here. Going through the crust, 57 gallons of low-cost Diesel fuel were consumed per day; 38 gallons when going through the sand. *Savings*, as compared with gasoline power, have been averaging *$4.58 a day*.

"Figgers" frequently are nuisances, but in this instance they sing the sweet tune of economy. No other type of power even approaches Diesel in low operating cost. Drillers are reporting savings of as much as a thousand dollars a well. Consuming cheap fuel, and using it sparingly, Diesel engines, as perfected by the foremost manufacturer in the field, are revolutionizing power standards—not only in well drilling, but in line pumping, dredging, excavating and other activities related to the oil and associated industries.

Now do you want further "figgers"? There's a "Caterpillar" dealer near you just itching to present you with some of the money-saving kind. Or, write us direct for literature on Diesel power in the oil fields.

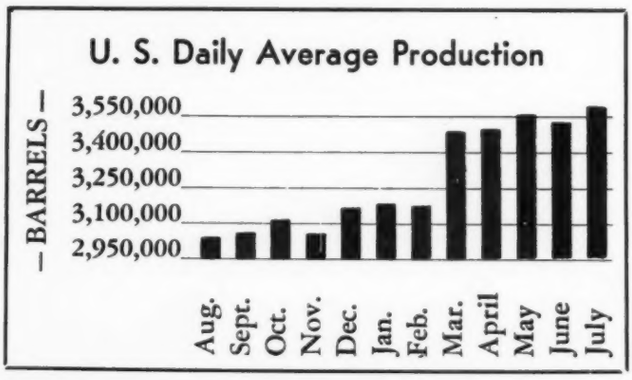
Seven engine sizes—44 to 160 hp.

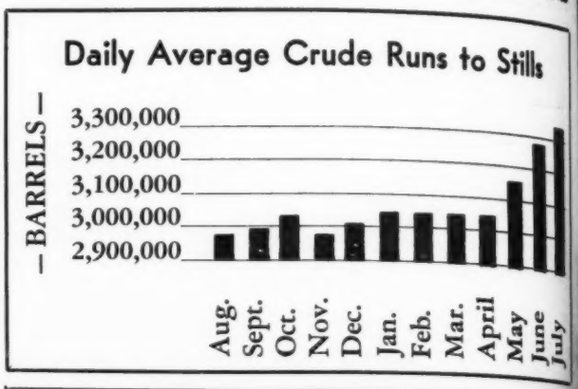
CATERPILLAR DIESEL ENGINES

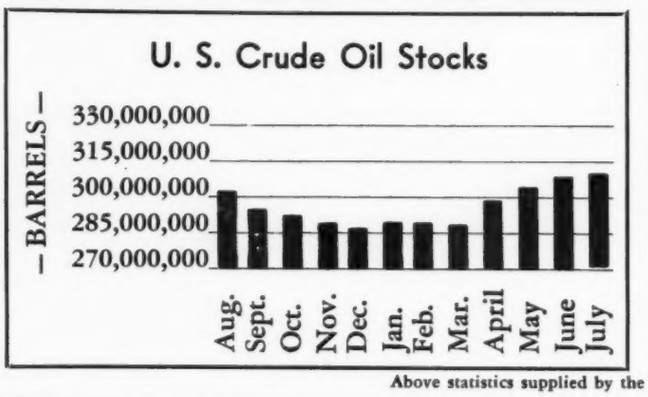
REG. U.S. PAT. OFF.

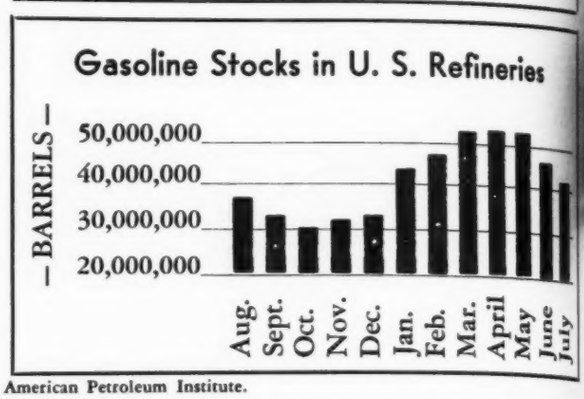
CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS . . . WORLD'S LARGEST MANUFACTURER OF DIESEL ENGINES

Summary of Petroleum Statistics and Field Activities









Above statistics supplied by the American Petroleum Institute.

Summarized Operations in Active Fields for July, 1937

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	251	245	55	95	3500-3700	2	40	Rotary
Duval County	76	62	21	60	1554-2900	2	22	Rotary
Archer County	37	12	2	14	660-1800	1 or 2	40	Rot.-Cab.
Panhandle	78	77	62	130	1700-3900	2	40	Rotary
Refugio	21	19	4	14	4900-5900	2	38	Rotary
Nueces County	59	50	25	65	3922-5878	2 or 3	21-54	Rotary
Winkler County	63	63	12	56	2850-3450	2 and 3	30-38	Rot.-Cab.
Talco Field	44	42	9	39	4230-4361	2	16-24	Rotary
Oklahoma								
Oklahoma City	16	15	2	7	6450-6682	3	39	Rotary
Fitts Pool	63	58	8	44	1800-4488	2 or 3	38	Rotary
Osage County	42	32	4	19	380-2850	2	37.5-40	Rot.-Cab.
Kansas								
Russell County	56	53	9	60	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	50	38	9	58	3222-4085	2 and 5	42-48	Rot.-Cab.
Reno County	17	17	4	27	3300-4375	2 and 5	42-48	Rot.-Cab.
Louisiana-Texas								
Rodessa	23	21	8	43	5950-6450	3	39	Rotary
New Mexico								
Lea County	52	48	40	109	3150-4036	3	30-34	Rot.-Cab.
California								
Kettleman Hills	5	5	1	11	8300-8730	3 or 4	40	Rotary
Wilmington	54	54	49	50	3500-4000	2 and 3	18-20	Rotary
Midway-Sunset	12	10	5	13	1400-3100	1 and 2	11-30	Rot.-Cab.

Field Activities by States for July, 1937

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1936 (In Barrels)
	July	June	July	June	July	June	July	June	July	June	
Arkansas	8	12	2	5	32	27	24	14	62	50	10,461,000
California	150	158	129	128	150	155	120	166	304	300	214,883,000
Colorado	....	....	....	....	....	....	3	4	39	35	1,670,000
Illinois	27	22	18	16	....	....	66**	59*	52	30	4,452,000
Indiana	12	13	6	7	....	....	2	3	29	41	795,000
Kansas	267	240	201	183	293	232	71	89	431	486	58,226,000
Kentucky	60	65	46	52	....	....	21	29	81	75	5,653,000
Louisiana	73	114	53	83	104	114	55	61	280	320	79,980,000
Michigan	106	93	87	79	93	117	98	116	174	173	11,852,000
Mississippi	....	....	....	....	....	....	5	6	13	12	Gas Prod.
Montana	21	25	15	24	....	....	6	8	66	64	5,632,000
New Mexico	58	70	53	67	....	....	19	24	154	156	27,134,000
New York	....	2	....	0	....	....	9	8	41	40	4,637,000
Ohio	122	134	84	94	....	....	93	94	269	273	3,834,000
Oklahoma	348	286	266	172	280	247	64	72	448	504	206,082,000
Pennsylvania	....	....	....	....	....	....	....	....	....	....	15,830,000
Texas	1416	1607	1113	1280	1679	1545	562	611	1951	2007	391,097,000
West Virginia	79	91	67	68	....	....	29	30	162	160	3,903,000
Wyoming	6	8	3	7	....	....	15	14	69	60	13,650,000
Total	2753	2940	2143	2265	2631	2437	1262	1408	4625	4786	993,942,000

*Including 36 rigs standing and 23 rigging up. **Including 41 rigs standing and 25 rigging up.

Familiar to many oil men are the famous "Ox Teams" that hauled equipment at Ranger, Texas, back in 1917 when the discovery well, McClesky No. 1, led the way to the development of the great Ranger Pool. Within a single year the field reached 60,000 barrels daily—a boom that put Ranger on the map and helped meet the tremendous war-time demand for oil.

The relative value of "inhibited" versus "raw" acid is not a matter of argument. So definitely is Dowell demonstrating the greater effectiveness, safety and ultimate economy of *Inhibited* Acidizing that thousands of oil producers, both large and small, will trust their properties only to Dowell.

ATTENTION DRILLING CONTRACTORS

Dowell's latest advance—Dowell Inhibited Heavy Acid—assures greater efficiency in loosening stuck drill pipe. Acid heavier than drilling mud is, in many cases, essential for successful freeing of pipe stuck at the bottom of the hole. Write to any Dowell office or station for The Acidizer, "Loosening Stuck Drill Pipe."

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OIL AND GAS WELL CHEMICAL SERVICE

The Month's Activities In Refining

Percent Refinery Capacity Operated

Western Division, 80.3 Percent **Central Division, 79.3 Percent** **Eastern Division, 85.5 Percent**

INCLUDING a new polymerization plant in its $2,000,000 construction program at Avon, Contra Costa County, refinery, Tide Water Associated Oil Company, Associated Division, has announced that Alco Products, Inc., has been given the contract for construction of the unit. The polymerization plant will be built in addition to the new cracking unit now under construction by Alco Products, it is stated.

Increasing the output, Associated's polymerization facilities will afford an annual production of more than 7,500,000 gal. of premium gasoline, it is estimated.

The new cracking units, now being installed, which incorporate the latest developments in petroleum refining, include a modern 3-coil cracking plant for optimum production of both volatile anti-knock gasoline and high-grade fuel oil. Provision has been made to break up a daily charge of 14,500 bbl. of oil into several fractions so that the bulk of fuel oil will be produced under conditions known to yield a product of excellent stability and heating value. The cracked gasoline largely will be manufactured under special cracking conditions favorable to a large yield of motor fuel of unusually high octane rating, officials of the company state.

One of the outstanding features of the polymerization plant is the proposed manufacture of a new premium grade gasoline with exceptional volatility and performance characteristics, from more than 5,000,000 cu. ft. of refinery gas daily.

In connection with the polymerization plant, engineers have selected the Girbotol process for the removal of hydrogen sulphide. This process, which was developed and is owned by the Girdler Corporation of Louisville, Kentucky, removes hydrogen sulphide from the refinery gases before polymerization. Such prior treatment of the poly charge makes unnecessary an after-treatment of the poly product, which otherwise would be required to remove objectionable sulphur compounds.

●

C. F. Braun Company, Los Angeles, California, has been awarded the contract for constructing the new Watson refinery of the Richfield Oil Company. Two combination crude topping and cracking units, each having a daily capacity of 30,000 bbl., will be installed. In addition to these units, and a gasoline treating and finishing plant, a polymerization unit will be constructed. The latter will have a daily capacity of 6,000,000 cu, ft. of gas.

●

Ethyl Gasoline Corporation has completed the addition to its new Baton Rouge, Louisiana, plant, thereby doubling its capacity. Since last October, Ethyl has put in $3,759,000 in plant and equipment at Baton Rouge.

The plant will manufacture tetraethyl lead and distill with Louisiana salt to produce its high-test gas constituent.

The plant is one of several oil and gas plants "sold" by Governor Richard W. Leche, under his new industrial expansion program. Governor Leche, since last November, has brought in 22 new plants and additions, all under the ten-year tax exemption contract between industry and state that the governor formulated.

●

The Kraco Refining Company has completed the construction of a 2000-bbl. skimming plant at Bryson, Texas. Crude is obtained from the Cockburn and Harper wells northeast of Bryson. John Kraker of Gladewater, Texas, is owner of the plant.

A second plant to begin operation in the pool is that of the Bryson Refining Company. This plant has a capacity of 600 bbl. daily.

●

Portex Oil Corporation, Portland, Oregon, is planning the erection of a gasoline plant in the Joaquin area of Shelby County, Texas, and will take production from gas-distillate producing wells. Further details concerning the plant, such as capacity, type, etc., have not been announced.

●

The United Gas Public Service Company has completed the enlargement of its gasoline plant in the Cotton Valley field of North Louisiana. Gas both from high- and low-pressure wells will be handled. The capacity of the plant is 30,000,000 cu. ft. daily.

●

A permit has been granted by the Arkansas Board of Conservation for construction of a carbon black plant in southwest Arkansas, near the Rodessa field. H. M. Barney, state senator of Texarkana, was given the permit, but it is understood that it was obtained on behalf of eastern capitalists. It is planned to use gas from the Louisiana side of the Rodessa field.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks

Week Ended July 31, 1937

A.P.I. Figures

(Figures in Barrels of 42 Gal. Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	584,000	87.3	18,116	11,394
Appalachian	88.4	111,000	86.0	2,835	870
Ind., Ill., Ky.	92.4	461,000	95.1	11,847	6,564
Okla., Kans., Mo.	84.6	315,000	82.9	7,067	3,323
Inland Texas	56.6	129,000	64.2	2,034	1,624
Texas Gulf	95.5	747,000	98.7	8,889	8,985
La. Gulf	96.3	149,000	94.3	1,792	2,570
No. La.-Ark.	63.7	38,000	65.5	473	414
Rocky Mt.	69.7	59,000	95.2	1,530	790
California	90.9	543,000	72.8	12,459	68,955
Reported	88.9	3,136,000	86.0	67,042	105,489
Est'd Unreported		289,000		3,830	2,720
*EST'D TOTAL U. S. July 31, '37		3,425,000		70,872	108,209
*EST'D TOTAL U. S. July 24, '37		3,380,000		72,020	106,260
U. S. B. of M. *July 31, 1936		**2,958,000		62,446	108,721

*Estimated Bureau of Mines' basis.

**July, 1936, daily average.

THE Petroleum Engineer

AUGUST, 1937

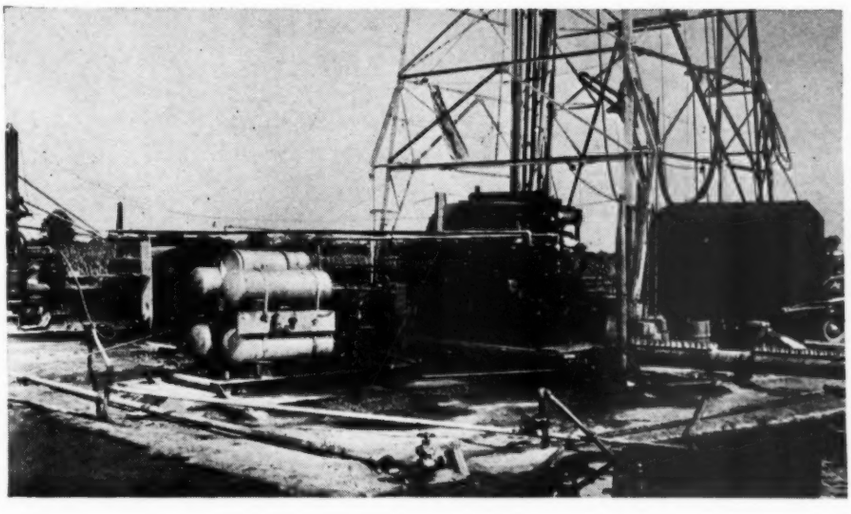
Significant Development in Illinois Basin Field

Drilling well seven miles from nearest producing well has earmarks of being good producer at depth of almost 3000 feet

By J. C. ALBRIGHT

WHAT appears to be one of the most significant developments in the Illinois Basin since discovery of deep production this spring, is the Ohio Oil Company's well, Arbuthnot No. 1, in the NW-NW-NW ¼, Sec. 8,Twp. 3 N, Range 9 E, Richland County, Illinois. This well is diagonally across the section from the small village of Noble, and approximately seven miles northeast of the nearest producing wells in the Clay City field where the Pure Oil Company's well Sarah Bechtel No. 1 recently was drilled-in for about 2700 bbl. daily.

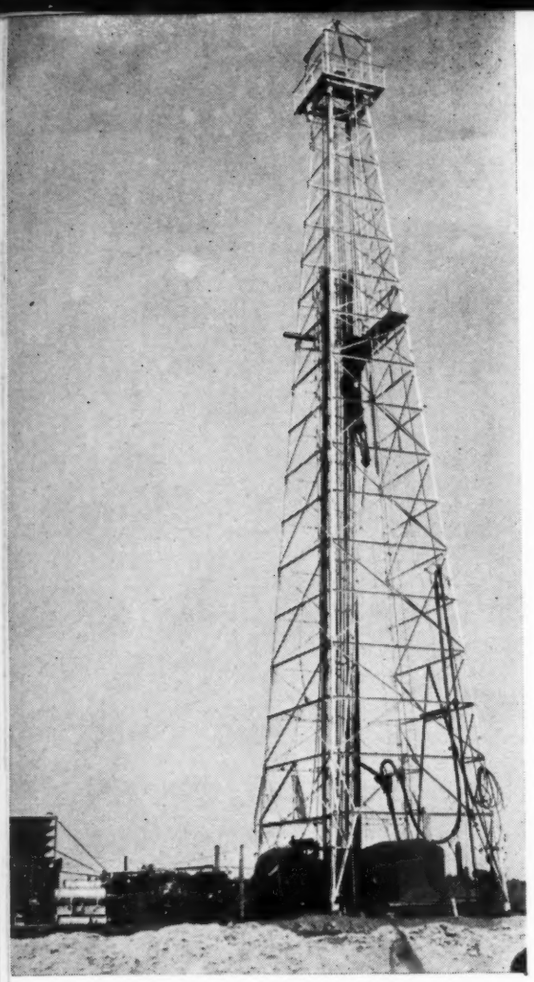
Well Arbuthnot No. 1 is on a geo-



Diesel engines used by Big West Drilling Company on the Arbuthnot No. 1

physical high, said to have approximately 40 ft. of closure, on which the Ohio Oil Company owns only 240 acres in the block, surrounded on all

View looking up into the derrick as drill pipe was being run in hole to clean after drill-stem test on July 29, 1937. Ohio Oil Company's Arbuthnot No. 1



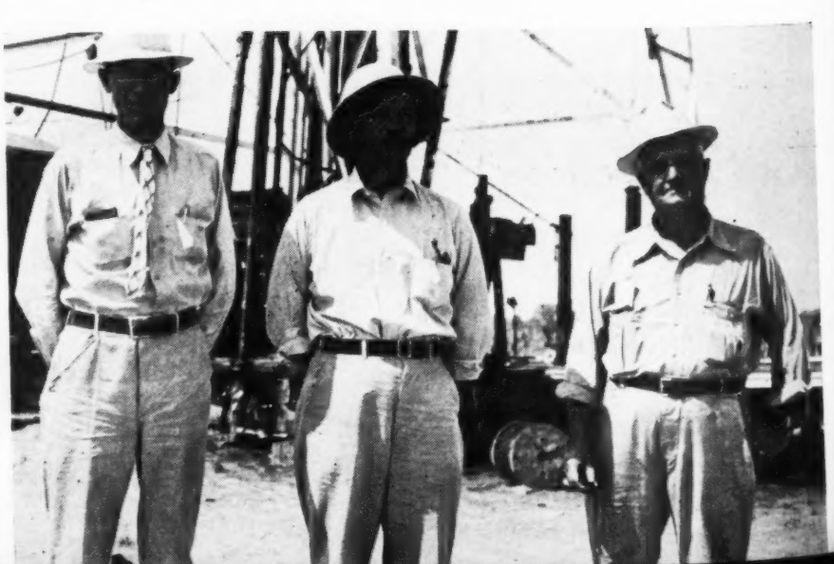
Ohio Oil Company Arbuthnot No. 1, NW-NW-NW Sec. 8, Twp. 3N, R. 9E, Richland County, Illinois. Unofficial estimates place production at 1500 bbl. daily on drill-stem test, July 29, 1937. The nearest production is seven miles southwest in the Clay City pool

sides by leases owned by the Pure Oil Company. This well was spudded-in early in July, and 210 ft. of 10-in. surface casing cemented, after which drilling was resumed and continued without difficulty until July 24th, when a core was taken that showed slight saturation in the very top of the McClosky. Coring ahead cautiously, frequent showings of oil were had until at depth of 2948 ft. a core taken in the Oolitic lime indicated extremely high saturation. This condition continued to 2963½ ft., when hard limestone was encountered but no further indication of oil; however, coring ahead was continued to 2988 ft. when on July 29 it was decided to run a drill-stem test. While the well was being tested, the well ran wild for a minute or so, spraying oil two-thirds the way up the derrick, and covering the surrounding ground and corn fields with oil, the reported gravity of which is 43 deg. A.P.I.

Though no official information is being divulged by the Ohio Oil Company, experienced operators who watched the test being made estimated the production of the well variously, some venturing the belief that it would be good for 2500 bbl. daily, the more conservative placing production at approximately 1500 barrels. As preparations were being made for the drill-stem test, Pure Oil Company brought in two crews of slush-pit diggers and completed preparations for three direct offset wells, drilling to begin immediately.

The Ohio well was drilled with a rotary rig much heavier than generally employed in the Illinois Basin, because a deep hole was contemplated if the McClosky were found to be dry. Diesel engines were used as prime movers, because suitable boiler water is difficult to obtain in that part of the county. With the exception of the 10-in. surface casing, the well was carried to

Crew of Big West Drilling Company on duty at time of drill-stem test of Ohio Oil Company's Arbuthnot No. 1, July 29, 1937, when it made its first flow. Left to right: M. V. Adams, driller; A. King, derrickman; Bill Flower, pipe racker; H. Coder, motorman; E. B. Fiscus, back-up man

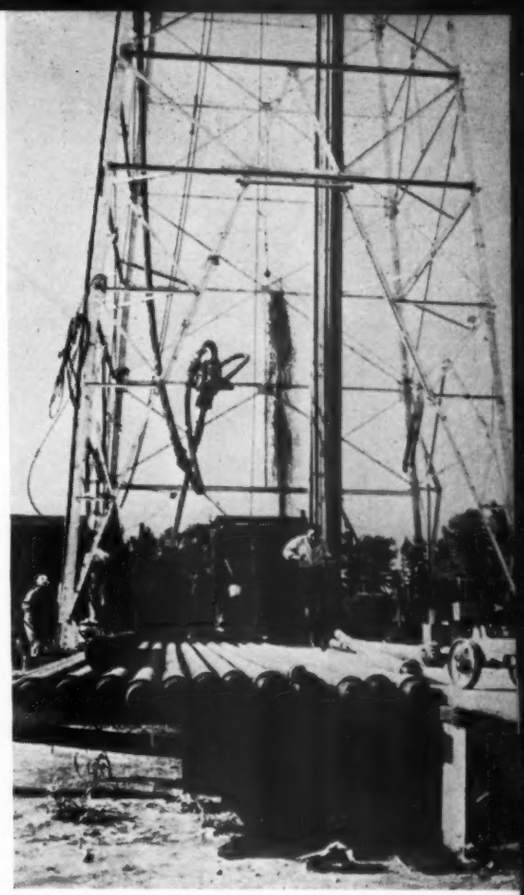


Technical staff of Ohio Oil Company at Arbuthnot No. 1 on morning of July 29, after well had made its first flow, estimated at 1500 bbl. daily from Oolitic lime. The bottom of hole was at 2988 ft. in the formation locally called the McClosky, which is lime or sand as the case may be. The high content of silica in the formation may preclude very wide use of acidizing. Left to right: R. E. Knipe, geologist; R. G. Kurtz, geologist; L. Bertrand, field supervisor

completion as an open hole. The pipe rack had been filled with 7-in. O.D. pipe to be run as an oil string if and when oil was found. Immediately after the drill-stem test was made, an electric coring unit was ordered out of Louisiana to obtain a test of the formation, after which the casing will be run and cemented. Ordinarily 72 hours are allowed for proper setting of the cement before drilling out the plug and making a complete test of production.

Many oil opreators are of the opinion that this well proves up a tremendous acreage in this part of Illinois, and provides a further impetus for the famous "Twenty-seven" county play throughout southeastern Illinois, Southwestern Indiana, and Western Kentucky. Many geophysical crews are at work "shooting" various parts of the country, and a few re-shooting the discovered structures prior to making final well locations. One prominent operator in the field estimates that approximately 6,500,000 acres now are under lease in the Basin, and that wells staked and contemplated should prove up the most extensive field yet discovered east of the Mississippi River.

Practically all tests are being drilled with internal combustion engines as prime movers, using either gas or oil as fuel. No tests near the more productive areas have been drilled with cable tools since the Pure Oil Company completed the first in the Clay City area; rotary rigs having been shipped in from Louisiana, Oklahoma, and Texas by the Pure Oil Company and several of the contractors, and crews brought in to operate the equipment.



Just as well made a flow and threatened to get out of control when making a drill-stem test. The oil is passing third girt of derrick

Anchoring Dresser Couplings on Pipe Lines

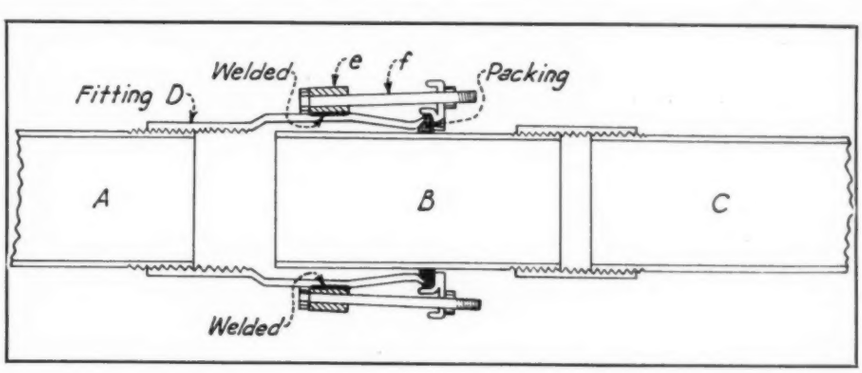
By W. J. GRISSETT[1]

DRESSER couplings on unburied pipe lines, unless anchored, have a tendency to "creep" down the line as the line contracts and expands and in time may slip from the end of one section of the pipe. The illustration indicates how such a coupling can be positively attached to one of the pipe sections. The sleeve of an ordinary long-sleeve Dresser coupling is cut crosswise in two equal parts, and pipe couplings of the same pipe size as the sleeve are welded onto the sleeve section, thus making two fittings from one Dresser coupling, and two pipe couplings. Short pieces of small pipe "e" are welded lengthwise outside the sleeve matching the bolt holes in the Dresser ring to receive the bolts "f."

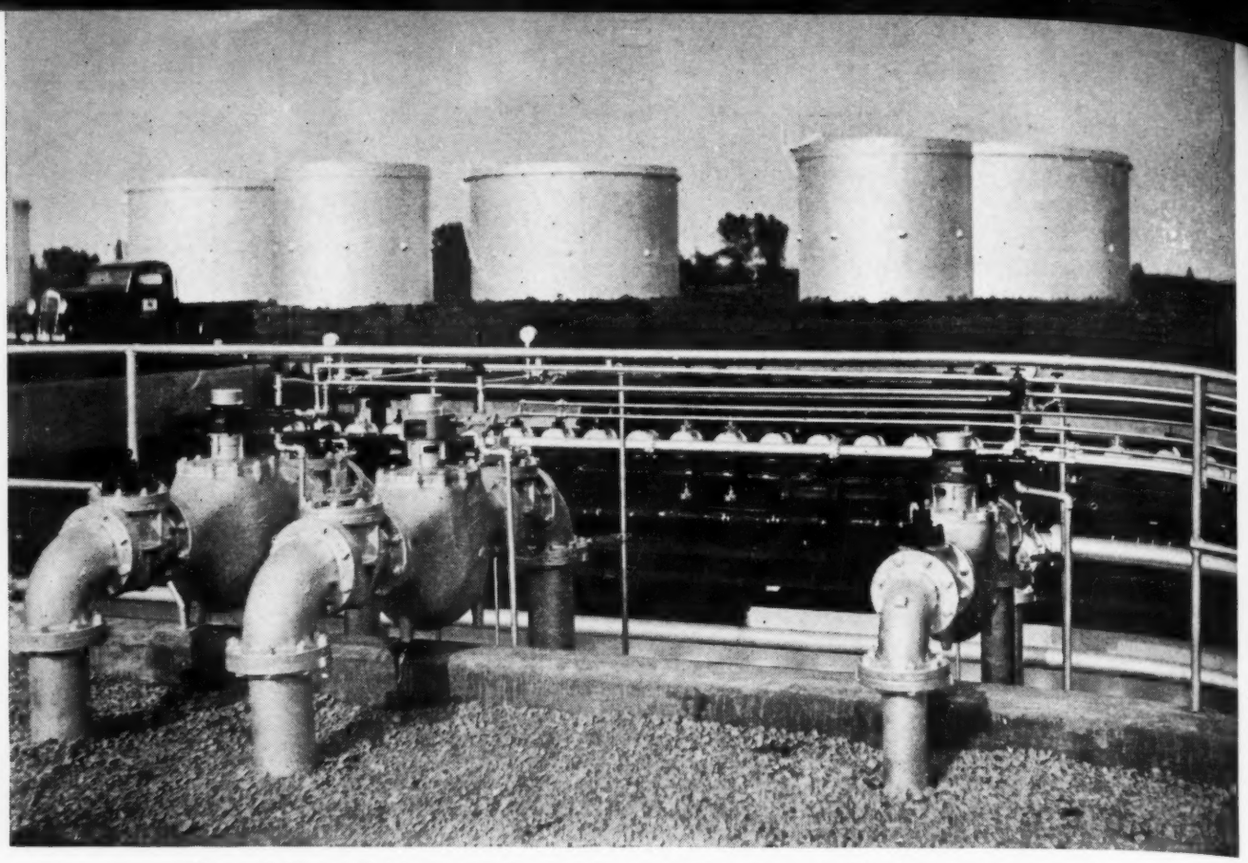
Due to the fact that most welded connections are not straight, it is often difficult to screw fitting D on section A while it is over section B. It will be easier to make up fitting D on section A, then insert nipple B in Dresser sleeve D and screw it into coupling of section C.

Dresser coupling gaskets can be replaced on pipe lines without parting the line by cutting the new gasket in one piece, making the cut with a 45-deg. slope lengthwise.

When regular Dresser gaskets are not available, valve stem or braided packings make a good substitute, but should be forced in place by tightening bolts then loosening and adding more packing until a joint is obtained.



[1]Big Lake Oil Company, Texon, Texas.



View of the manifold; meters shown in foreground, and a part of tankage in background

Features of White Eagle's Pipe Line Terminal at Kansas City

By FRANK H. LOVE

Equipment of latest type, some of which was designed by company engineers and used for first time at this plant — certain departures in operating methods have proved highly successful

THE Kansas City, Kansas, pipe line terminal of the Socony-Vacuum Oil Company, Inc., White Eagle Division, placed in operation at the time the company recently completed its new 6-in. gasoline pipe line between Augusta, Kansas, and Kansas City, is an excellent example of a modern plant of this kind. Equipment is of the latest type, some of it being designed by the White Eagle technical staff and used for the first time at this terminal. Of interest also are certain departures in operating methods, which have proved highly successful in their application.

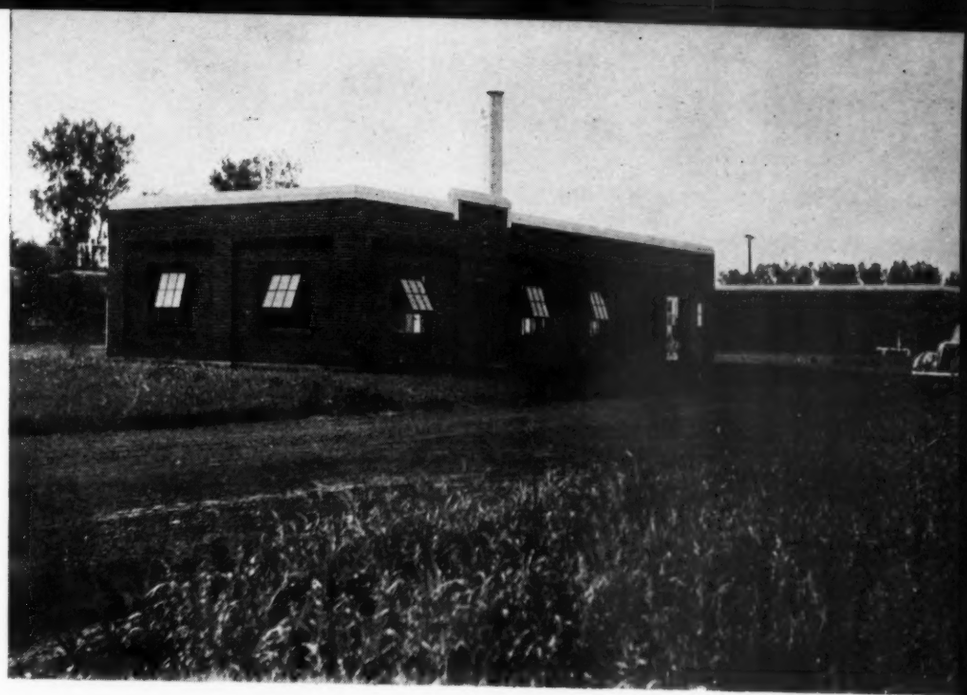
The terminal is situated on a 60-acre tract adjacent to the Missouri River. Products processed at the Augusta, Kansas, refinery of the company are handled through the line. A relay station is operated at Emporia, Kansas. The line is operated at a pressure of approximately 800 pounds.

Upon arrival at the terminal the products are taken through the manifold and into storage tanks that have a total capacity of approximately 340,000 barrels. All tanks have pontoon-type floating roofs except one, which is a 10,000-bbl. 15-lb. spheroid tank. The tanks vary in capacity from 5000 to 55,000 barrels.

Distribution from the terminal is by rail to central and northern territories. As a result of pumping to Kansas City and shipping from this terminal by tank car a saving of from 12 to 24 hours is effected in the time required to make a delivery as compared with the time required to ship direct from Augusta.

For loading tank cars a loading rack has been provided that has a capacity for spotting 30 cars. Submerged loading is practiced. Connections are perfectly tight all the way to the bottom of the tank car. The design of the apparatus employed in loading materially reduces evaporation losses. Transferring products from storage to tank cars is accomplished with centrifugal motor-driven pumps situated in a pump room of brick construction.

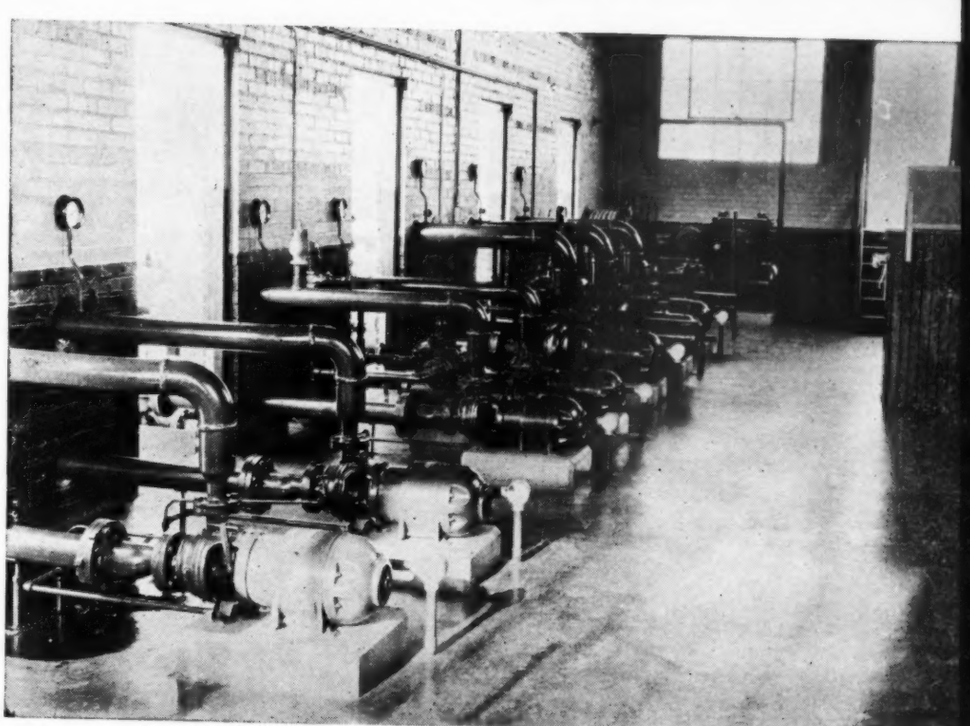
The manifold, constructed of 6-in. and 8-in. pipe, is of all-welded fabrication entirely equipped with plug valves. In designing the manifold a policy of simplicity was observed, resulting in an efficient unit. Each line



All buildings are of brick construction. The one in the foreground is the main office building

is plainly stenciled with the name of the product it carries, and, in addition, the gate valves have been painted different colors, this double precaution avoiding all possibility of error.

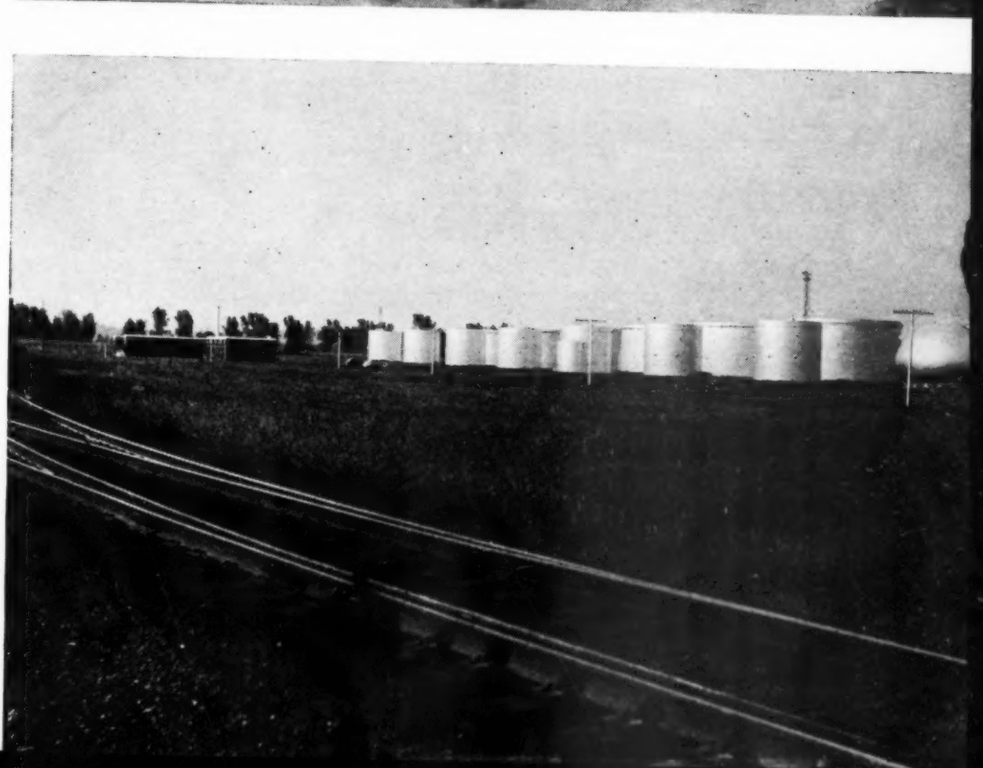
A sewage system has been provided to recover all products that may have escaped from one source or another. Gravitating into a concrete sump, they are picked up and salvaged, being used principally for fuel in the steam plant. The latter consists of a low-pressure boiler operated at 15-lb. pressure, generating steam for heating, cleaning, and fire-fighting purposes. In connection with the latter, steam lines lead to the loading rack, to the ends of which are attached nozzles that can be hooked over domes of cars, effectually smothering the flames in event of fire. Additional fire-fighting equipment is a foam system consisting of hoppers mounted on wheels. A fire hose runs through the base and as the dry powder passes through the hoppers it mixes with water, forming foam. A 6-in. water main loops the plant, with fire hydrants placed at strategic points.



Centrifugal pumps are used to transfer products from storage tanks to the loading rack. Here is shown an interior view of the pump room

The terminal occupies a beautiful site. The grounds are spacious, well kept, and lighted by flood lights at night. All buildings are of brick construction.

A notable feature of the terminal is the small evaporation loss experienced since the plant has been in operation. This is attributable to the type of storage tanks used and to the closed system of loading tank cars.



View of a portion of the terminal; tankage to the right, buildings to the left. Farther to the left, but not shown in this picture, is the loading rack

Improved Aids For Drilling-in and Tubing Wells Under Controlled Pressure

By

A. PRANGER[1]

IT IS becoming accepted practice to drill-in rotary wells under controlled pressure in fields where the producing formation is permeable limestone or where the producing sands are under low pressure.

When this method is used the drilling fluid is made light enough to permit the formation being drilled to produce oil and gas while drilling is in progress. The drilling fluid usually is oil, gas, or water, or gas mixed with oil or water.

If the bottom-hole pressure is low a column of heavy drilling fluid may cause clogging of the sands and impair the production of the well when it is brought-in. Even a column of oil with no gas in solution may be undesirable as a drilling fluid because of its weight. To lighten the circulating column the injection of extraneous gas into the drilling fluid is resorted to; but sometimes a well produces enough gas while drilling to maintain the required weight without resorting to the use of gas from an extraneous source.

By drilling-in under controlled pressure the productivity of the sands penetrated can be determined with fair accuracy before the well is completed; also, as the cuttings are carried rapidly to the surface it enables the operator to determine the location and character of the pay sands and intervening strata. Experience shows that when this method of drilling-in is employed more hole per bit can be made because of the rapid removal of the cuttings from the bottom of the hole and the jetting action of the oil and gas across the cutting edges of the bit; also, the necessity for washing-in the well is eliminated.

In the method of drilling-in under controlled pressure, some type of packing arrangement has to be provided between the drill stem and the casing while the drill pipe is rotated and moved up and down.

Though the flow pressure usually is held to a minimum, in order to avoid having to snub part of the drill pipe in or out of the hole, the equipment must be strong enough to withstand much higher pressures in case of an emergency.

In some instances the conventional square kelly joint is used and a pack-off provided for same, but usually a joint of flush-joint pipe or standard drill pipe with collars is employed as a kelly with a suitable, adjustable gripping device in the rotary to drive the round kelly.

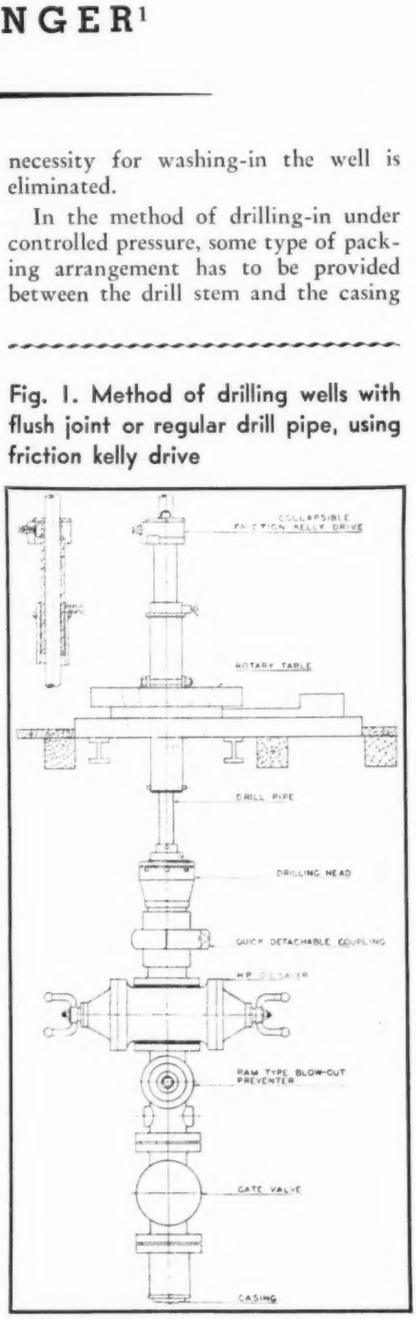
As controlled pressure drilling has grown in importance, equipment manufacturers and operators have coöperated in designing more suitable, safer, and economical equipment for this purpose than that developed when the method was first introduced.

A simple and economical hook-up now used extensively is shown in Fig. 1. Immediately after the casing is cemented and while waiting on the cement to set the controlled-pressure drilling equipment is installed above the blow-out preventer of the drilling Christmas tree and all other piping connections made; so there is no delay in completing the well.

A typical installation consists of a high-pressure oil saver, through the rams of which the conventional flush-joint or standard drill pipe with tool joints may be run or pulled against the well pressure without leakage. When drilling ahead, this same oil-saver serves as a pack-off around the rotating kelly, thus eliminating the necessity of a separate packing device. When standard drill pipe with tool joints is used, care is taken that the tool joint does not rotate inside of the oil-saver rubbers. To prevent this, it is customary to use a long and a short joint of drill pipe alternately directly under the joint of pipe that is used as the kelly.

The oil-saver consists primarily of a housing in which are two opposed rubber rams, operated by screws from the outside of the housing. The faces of the rubbers are fluted horizontally to provide flexibility and allow pipe collars to pass without leakage. Interlocking tongues and grooves on the faces of the rubbers adjacent to the horizontal flutes assure a leak-proof pack-off at these points when the rubbers are closed around the drill pipe. The lower end of the rubber is provided with a circular groove, forming a sealing lip around the pipe at this point, the sealing effect of which increases as the well pressure increases. The rub-

Fig. 1. Method of drilling wells with flush joint or regular drill pipe, using friction kelly drive



[1]Chief Engineer, The Guiberson Corporation, Dallas, Texas.

bers may be retracted in the oil-saver housing to permit passage of the bit and other tools having much larger diameters than the drill pipe without removing the oil-saver from the Christmas tree. The rubbers are easily removed by simply removing the two end plates on the housing. These oil-savers are compact, so take up a minimum of space, and are available in a variety of sizes to suit different sizes of casing and Christmas-tree fittings.

When the oil-saver is used also as a pack-off or stuffing box while rotating the drill pipe, it is obvious that in order to prevent the rubber from being torn by scarred drill pipe or kelly, a kelly drive should be used that grips the round kelly in a positive manner without cutting it to the extent where it would destroy the oil-saver rubbers.

This objectionable feature has been eliminated on the drive shown in Fig. 1. The drive consists of a short section of regular square kelly bored out to fit different diameters of pipe, at the upper end of which is a gripping arrangement for clamping the drive onto the kelly. A unique arrangement of the three dies in the gripping device eliminates the possibility of the pipe slipping in the drive for either direction of rotation. When ready to drill ahead the oil-saver rubbers being closed around the drill stem or the pipe, the drive is clamped onto the joint to be used as the kelly with the lower end of the kelly portion of the drive just entering the square in the rotary-table kelly bushing, so that when the rotary turns, the drill pipe through the gripping arrangement on the drive is rotated, and drilling can proceed in the conventional manner until the top of the drive comes in contact with the rotary table. The clamp is then loosened, and the drive moved up the kelly by means of the cat line and again clamped on the kelly, and the assembly is ready to drill again the approximate length of the square portion of the drive. A water line to the top of the rubbers provides water for lubrication at this point.

Where cellar space is limited, and where no derrick substructure is used, even if the rotary table is mounted above the derrick floor, the top of the oil-saver very often is close to the bottom of the rotary table, in which case the drive just described can be equipped with a telescoping attachment, which is in fact a long rotary kelly bushing consisting of a square housing that can slide through a special kelly bushing that fits in the same place as the regular kelly bushing. The square hole through this housing fits the square shank of the regular drive and allows the latter to slide in the housing. A clamping device on the housing limits the movement of the housing through the rotary table to any desired or necessary amount. This combination drive (see Fig. 2), if cellar space is available, enables more hole to be drilled before it is necessary to raise and reclamp the drive.

If the operator does not care to use his oil-saver equipment for a pack-off while rotating, or if there is danger of encountering very high pressures during the drilling-in operation, a separate drilling head or rotating blow-out preventer may be installed above the oil-saver by means of a quick-changing union, as shown in Fig. 2. Stuffing boxes of various designs have been used for this purpose, in most of which the pipe rotates inside of the packing material.

On one drilling head placed on the market only recently, the packing medium rotates with the kelly, and the only wear occurring in the packing is that of the up-and-down movement of the drill pipe. The friction hold between the kelly and the Neoprene packing rotates the packing sleeve assembly inside the stationary housing of this drilling head. The sleeve is mounted on two opposing, heavy-duty, tapered roller bearings, which in turn are mounted in the housing and take all the upward or downward load due to the pipe moving vertically through this head. These bearings are mounted in a dust-proof and oil-tight compartment in the housing and run in a bath of oil.

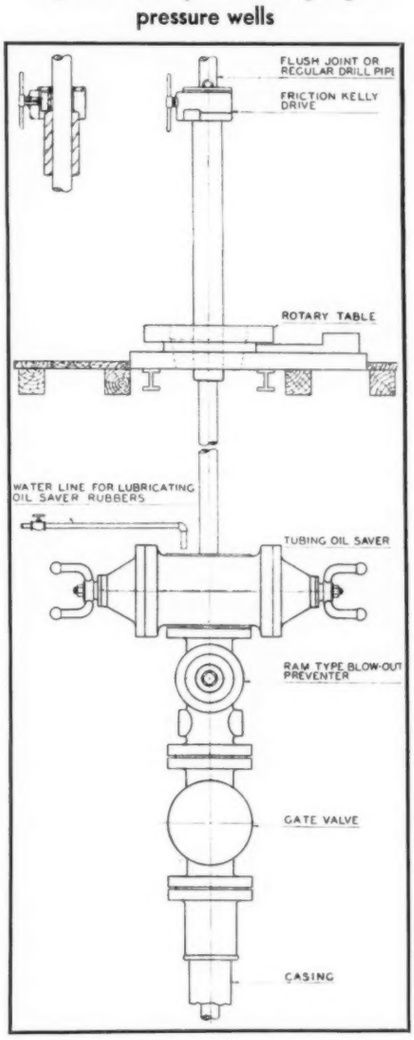
The Neoprene aligning cushion vulcanized between the packing stuffing box and the sleeve allows for misalignment of the kelly in the drilling head and absorbs the shock load due to the kelly whip.

When this tool is used with flush-joint pipe, it is only necessary to remove it from the oil saver below the head when the bit is removed from the hole. While drilling, the pipe may be raised or lowered through this head without having to close the oil-saver rams; this prolongs the life of the oil-saver rubbers.

When used with standard drill pipe, one joint of this pipe usually is employed as the kelly. When a connection has to be made, the quick-changing union is loosened, and the head, supported by the lower tool joint on the kelly, is removed with the kelly through the rotary table and replaced immediately after the connection is made. When going in or coming out of the hole with the drill pipe, the drilling head is removed with the kelly, and the oil-saver scrubbers are closed around the drill pipe, so that the latter can be pulled under pressure without leakage.

The same method with the same equipment also is used extensively for cleaning out wells after shooting with nitroglycerine. The large volume of high-pressure gas used lightens the oil and increases the velocity of the column, which loosens the cuttings in the hole and carries them to the surface much faster. This method of cleaning out takes about one-tenth of the time formerly required for such work, and in practically all cases wells are completed in better condition.

Fig. 2. Hook-up for drilling high-pressure wells



Tubing Wells Under Pressure

High-pressure oil-savers are successfully employed for tubing wells under pressure and are widely used for this purpose. The difference in diameter of collar and pipe on tubing being much less than on drill pipe the wear on the rubbers is less and consequently they last longer.

Fig. 3 shows a typical hook-up for tubing wells under pressure. If high pressures are anticipated a blow-out preventer is installed below the oil-saver, so that when the rubbers need replacing or in case of emergency, the well can be shut in with the blow-out preventer. As soon as the tubing is landed in the tubing head, the oil-saver and blow-out preventer may be removed from the tubing head, and standard Christmas tree fittings installed.

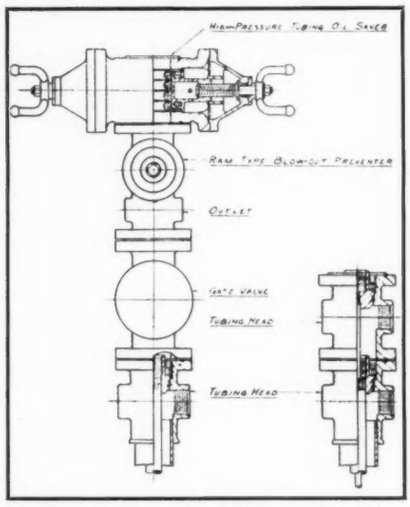


Fig. 3. Hook-up for tubing wells under pressure. Left — For single string of tubing. Right—For two strings of tubing

A hook-up for low-pressure wells is shown in Fig. 4. In operation the oil-saver rubbers are open, and the tubing is run through a stripper head until the final joint, containing the boll weevil or landing mandrel, is ready to pass. The oil-saver rubbers are then closed, and the split type of tubing stripper removed until the landing mandrel passes through the stripper adapter, after which the stripper is replaced around the tubing, and the oil-saver rubbers are opened to pass the mandrel onto its tubing head, after which the oil-saver and stripper can be removed. This equipment may be installed above the gate valve at any time for work-over jobs without having to kill the well. Instead of a stripper above the oil-saver, another oil-saver sometimes is used.

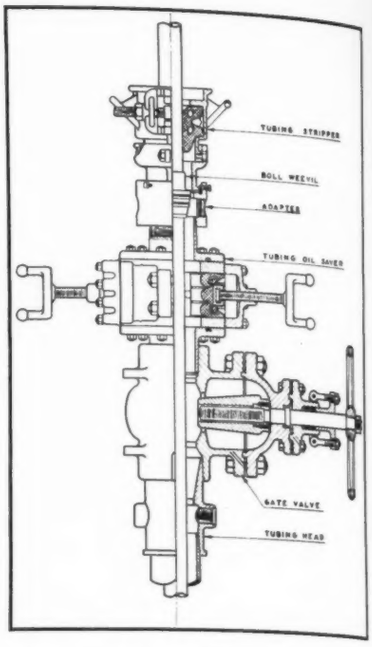


Fig. 4. Tubing stripper and oil saver hook-up for tubing wells under pressure

Plant for Purifying Refining Gas by the Phenolate Process

THE Atlantic Refining Company has placed in operation at its Philadelphia refinery the first plant in the east that will purify refinery gas by the new Koppers phenolate process. The plant was erected by Koppers Company's Engineering and Construction Division.

Koppers Company also has just completed a similar type of plant to purify natural gas at Wayne, West Virginia, for the Chartiers Oil Company. It will be placed in operation about August 1, will remove 95 percent of the hydrogen sulphide in the gas, and will have a capacity of 5,000,000 cu. ft. daily.

The first of these plants was erected by Koppers Company at El Segundo, near Los Angeles, California, for the Standard Oil Company of California and was put in operation August 6, 1936.

This new process is adaptable for the recovery of hydrogen sulphide from natural gas and refinery still gases, with purification efficiency varying from 95 to 99.8 percent. This renders the gas suitable for treatment in a polymerization unit for production of liquid hydrocarbons.

The plant built for The Atlantic Refining Company will be able to recover the hydrogen sulphide from 22,000,000 cu. ft. daily of refinery still gases at 225-lb. pressure. The hydrogen sulphide may be converted to sulphuric acid and the purified still gas will be processed further by polymerization.

The purification system consists of an absorption stage and an actification stage, through which the Phenolate solution is circulated continuously. This solution has an extremely high carrying capacity for hydrogen sulphide, and as a result, it is necessary to circulate only five to ten gal. of solution per M cu. ft. of sour gas.

The hydrogen - sulphide - laden gas enters the absorber at the base, passes up through the bubble-cap trays, and leaves at the top, stripped of 95 percent or more of its hydrogen sulphide. The solution leaving the bottom of the absorber, saturated with hydrogen sulphide with respect to the incoming gas, passes through the heat-exchanger tubes to the top tray of the actifier. It flows down over the actifier trays, counter-currently to the stripping steam that is generated in the reboiler at the base. Sufficient indirect steam is used to effect the desired degree of actification of the solution. This, in turn, is determined by the maximum residual hydrogen sulphide desired in the exit gas.

The actified solution flows from the reboiler through the heat-exchanger shell, is further cooled in the solution cooler, and is then pumped to the fourth tray below the top of the absorber. The absorption cycle starts again at this point.

Hydrogen - sulphide - laden steam passes from the top of the actifier to the dephlegmator shell and thence the hydrogen sulphide is forced, by the actifier pressure, to the acid plant burner or other point of disposal. Condensate from the dephlegmator returns to the actifying column.

Fresh water is added continuously to the top tray of the absorber. The three top trays comprise, in effect, a water scrubber to recover chemicals that have been entrained or evaporated from the solution. It is necessary, at periods of several days, to replenish chemicals lost from the system, and a small mixing tank is provided for this purpose. The caustic soda and crude phenol used in the process are inexpensive and are commonly used commodities that are readily available on the open market.

This system is completely adaptable to a wide variation in conditions such as hydrogen sulphide concentration, pressure and composition of the gas to be treated.

Kettleman Hills Well Attains New Record Production Depth for California

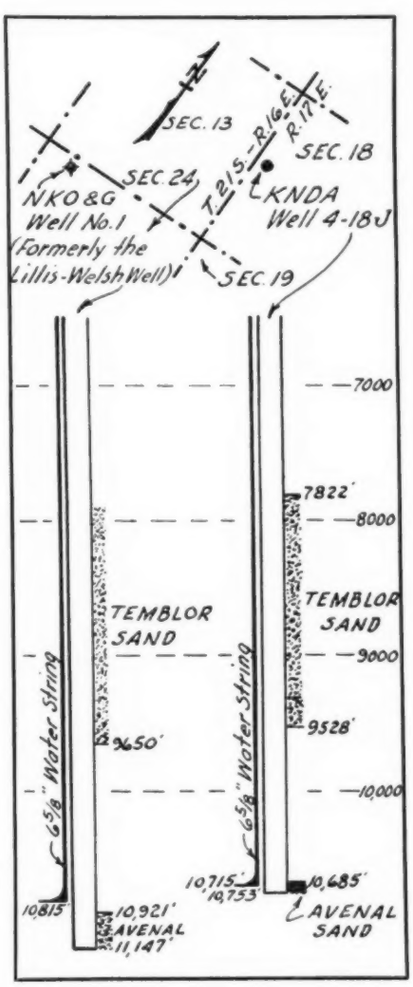
Present depth of well 10,753 feet—Initial Production 1172 bbl. per day—Flowing pressure 2750 lb. per sq. inch

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

TOPPING the Avenal Sand at 10,685 ft. and drilled to a total depth of 10,753 ft., Kettleman North Dome Association well No. 4-18J has tapped the deepest commercial oil production yet found in California. This well, in the NW¼ of section 18-21S-17E, is the most northerly productive location in the North Dome of Kettleman Hills. It is an outpost well that extends the known productive area of the Avenal sand to the north and is an edge well in the Temblor formation. Production for the first 24 hours was 1172 bbl. of 45.7-deg. A.P.I. oil and 20,000,000 cu. ft. of gas.

The formations penetrated checked with those in the NKO&G well originally drilled by Ed McAdams as Lillis-Welsh No. 1 and later carried to a depth of 11,147 ft. by the Union Oil Company. These two wells are about one mile apart and the Kettleman North Dome Association new well is a little farther north and almost a mile east. Showings of oil were found in the Avenal sandstone in the old Lillis-Welsh well, but both this sand and the Temblor are lower structurally than in the well just drilled. The relative surface locations and the lower formations of the two wells are shown on the accompanying sketch.

Production from Kettleman North Dome Association well No. 4-18J began flowing on July 22. Only one trap was used and the oil and gas were produced through tubing with one bean on the flow line. It was attempted to keep the bean at 50/64 in. but it cut out rapidly. The flowing pressure was 2750 lb. per sq. inch. A 6⅝-in. water string had been cemented at 10,715 ft. and a 4¾-in. aluminum liner run into the hole. This liner, however, stuck at 10,723 ft. and thus is 30 ft. off bottom.



Relative surface locations and the lower formations of Kettleman North Dome Association's Well No. 4-18J and the NKO & G Well No. 1, formerly the Lillis-Welsh No. 1

The oil produced was cut approximately eight percent. This probably was due, however, to the fluid column around the tubing getting into the stream, as the space behind the tubing was not opened. The cut was water and mud, having a maximum salt content of only 41 grains per gal.—a quantity that indicates fresh water.

After making a test, the well was killed, the pressure before killing being 2550 lb. per sq. inch. The procedure to be followed will be determined later, as this is an outpost well and deeper drilling may be decided upon. The aluminum liner can be readily drilled-up and a steel liner substituted if it is decided to produce the well at its present depth. In its existing good condition, the well can be drilled deeper to determine whether there is a difference in sand or a difference in the character of production at a lower depth.

Should this well be completed as a producer at its present depth, it still will be the deepest producing well in California. Until it was tested at 10,753 ft., Tidewater-Associated's well McGonigle No. 12 completed in January in the Ventura Avenue field held the state's record at 10,569 feet. Production from the McGonigle well during the first 23 hours was 533 bbl. through a 55/64-in. bean—considerably less than the flow of the Kettleman Hills well, which is nearly 1200 bbl. daily. The deepest producing well in the world is Humble's No. 1 Ellender in Terrebonne Parish, Louisiana; but production from this well, although initially 23 bbl. an hour when completed in May, is now less than 300 bbl. daily.

The Dehydration of Natural Gas

Part 2

By JAS. R. COWLES

Advantages of Dehydration

Summary. Allyne[8] lists the following advantages of dehydration:

1. Prevention of internal corrosion.
2. Increases line capacity due to:
   A. Prevention of clogging by condensed water
   B. Less roughening of pipe walls by corrosion
   C. Elimination of freeze-ups
3. Elimination of drips
4. Reduces shutdowns, leaks, and ruptured lines
5. Prevents dust problems in distribution systems

From one of Hammerschmidt's papers may be added, the inaccuracies introduced in orifice meters by the formation of hydrates on the orifice plate.[1]

Considering those that are not self-explanatory in the order that they are listed:

Internal Corrosion

Dehydration is not generally practiced for the prevention of this alone, however, this is found to be the case on the Pacific Coast. The electrolytic theory of corrosion requires that there be liquid water present if corrosion take place.[9] Such water chiefly will be condensed water, though rust films under some conditions can absorb water from a humid gas. This water alone can cause corrosion, but the rate is greatly increased when hydrogen sulphide, and/or oxygen is present. Pickup, and his associates, found that they were experiencing serious corrosion due to water, and almost undetectable quantities of hydrogen sulphide.[6] In any event dehydration has eliminated this to a very great degree, even with a comparatively imperfect plant. Just as noticeable was the increase in ultimate line capacity, due in part to less restriction of the pipe by corrosion products (in the case in point the line was cleaned after the installation of the dehydration plant), and the increased smoothness of the pipe walls.

Increase in Line Capacity

Mention has been made of the corrosion phase of this point. The elimination of condensed water perhaps is as great a factor as any in the improvements already cited. As yet no means has been found to place drips with any precision; therefore, where condensed water is possible, there is a potential obstruction of the line. Freeze-ups are well known, but the effects of partial stoppage possibly have been underestimated.

Elimination of Drips

These have been found unsatisfactory for the reason just mentioned. In addition, the waste of gas incurred by the necessary blowing-off is becoming increasingly important. In a line of great length, dependence upon drips, even when freezing is not eminent, constitutes a serious encroachment on returns from the investment made due to gas that must be blown.

Reducing Shutdowns, Leaks, and Ruptured Lines

As Allyne's major interest is in corrosion it is probable that this refers to the weakening effect from pitting of pipes.

Dilution by Water Vapor

This factor is not usually discussed in connection with advantages of dehydration, undoubtedly because of its magnitude. The calculations are not involved, but they are somewhat tricky; therefore, the reader is advised to refer to a more detailed discussion than is appropriate here.[10, 5, e]

To show the order of magnitude the case of saturated gas at 400-lb. per sq. in. pressure and 48 deg. fahr. may be considered.[10] Under these conditions the water content is 21.7 lb. per million cu. ft. water vapor gas mixture (as may be verified by use of Fig. 2). In terms of the usual cu. ft. the volume is 457 cu. feet. Thus the total water content occupies a volume less than the error expected in the most recent specifications for orifice meter settings. It must be borne in mind, however, that this does not represent the change in volume caused by dehydration. If the gas were cooled to 34 deg. fahr. the corresponding volume would be 267 cu. ft., giving approximately a decrease of 190 cu. feet.

As stated, the foregoing example is not of value except to show that the effect of change in dilution is not great.

Methods of Dehydration

General. The recognized methods of drying are:

1. Adsorption
2. Absorption
   A. By solids
   B. By liquids
3. Refrigeration
   A. Compression
   B. Absorption
   C. Atmospheric
   D. Water
      (1) Gas jet for vacuum
      (2) Steam jet for vacuum
4. Refrigeration and absorption
5. Compression

Of these, absorption by refrigerated brines is the method most generally favored at the present time. Absorption by unrefrigerated liquids is being practiced extensively and in the future may prove to be the more popular. Many of the other methods are not generally applicable. Others have undesirable features, hence some of them merely will be identified in the following paragraphs.

Adsorption, and absorption plant sizes depend chiefly on the weight of the water that must be removed. Refrigeration plant sizes depend on the weight of gas to be handled, and the degree of cooling necessary. This is due to the fact that the gas leaves the plant at a sub-normal temperature, the loss in plant work being proportional to the weight of the gas and the temperature difference of the entering and leaving gas. Compression plants belong in the group of special types.

Adsorption Method

This will be discussed in the section on the adsorption plant.

Absorption Method

This depends on the ability of an agent to remove water by its absorptive power, which is analogous to the combination of gas with water to form the unstable hydrates. Such absorbed water is removed by heating. The process is so arranged that it is a continuous one.

At the present time solid absorbents, such as solid calcium chloride, present too many difficulties, the main ones being the necessity of using a cyclical process (in comparison with a continuous one involving less attention, and only one unit), and the physical properties of the agent after absorbing some water, such as stickiness, mechanical weakness, and, chiefly, increased size.

Liquid absorbents have been found satisfactory where their ability as such is sufficient. Among agents that have been, and are being used are: glycerine, diethylene glycol, thiocyanates,[f] and calcium chloride solutions. Others have met with minor success. The rejuvenation of glycerine requires vacuum distillation, which, though apparently practical around manufactured gas plants, seems to be a bar to its application to natural gas; it has been tried, however. Diethylene glycol resembles glycerine in many respects. It is a comparatively new commercial chemical, therefore, little data are available in the literature. No vacuum distillation is necessary in its case, though a rectification tower apparently is advisable.

e) The first reference, a personal communication, is expected to appear soon in "Industrial and Engineering Chemistry".

f) The author knows of no case where this agent has been used with natural gas.

It will be discussed further later. Thiocyantes are unpleasant to use, and apparently have little to commend them. Calcium chloride brines will be discussed in connection with refrigerated brine plants.

Refrigeration

This is the classical method, being the first outstanding method used to dehydrate natural gas.[7] Unfortunately little was known of gas hydrates at that time and the effect of these has occasioned so much difficulty that the trend has been toward other types of plants. From the preceding discussion it is obvious that with refrigeration hydrates will tend to form in the refrigerating coils. This effect even has been serious when the cooling medium was water cooled in an atmospheric cooling tower. (Dehydration by atmospheric cooling).[6, 8]

As stated, the difficulties afforded with refrigeration plants have tended to lessen their popularity; however, such plants are operating satisfactorily. Fig. 3 is a general flow sheet of such a plant. Propane or butane generally are used as the refrigerating medium, though there is no restriction. Ammonia also is being used.[11]

Compression Refrigeration

In this system the gas is compressed, cooled in an atmospheric cooling tower, and then allowed to expand sufficiently to cool to the required dew-point. The condensed water is removed by means of a drip. The method is too costly except in special cases where the equipment need not be purchased for that use alone.

Absorption Refrigeration[12]

Refrigeration is produced in this case by using the general principle of the Electrolux household refrigerator. Its low efficiency limits it to cases where plenty of cheap heat is available, usually in the form of exhaust steam. Apparently it has not been applied to natural gas.

Water as a Refrigerant[12]

Cooling is produced in this case by the evaporation of water under vacuum. The latter is supplied by either a steam or gas jet.[g] In the case of the gas jet the limitations are much the same as with compression refrigeration. The steam jet may find application where steam is feasible. It is not a favored method at present but with the development of water as a refrigerant in air-conditioning it as a possibility when a dew-point above 32 deg. fahr. is sufficient.

[g] A jet is an arrangement where, e.g., steam is conducted through a restricted passage in such a way that subatmospheric pressure is available.

Combined Absorption and Refrigeration. This arrangement uses a cooled brine. It avoids hydrates by the presence of the brines and, due to the properties of the brine, does not require as low temperatures as straight refrigeration. It is the method most favored at the present time, hence will be discussed in detail in a separate section.

Compression Method. This method depends upon reducing the volume of the gas by compression until it can hold only the desired amount of water. It is not adapted to high-pressure gas.

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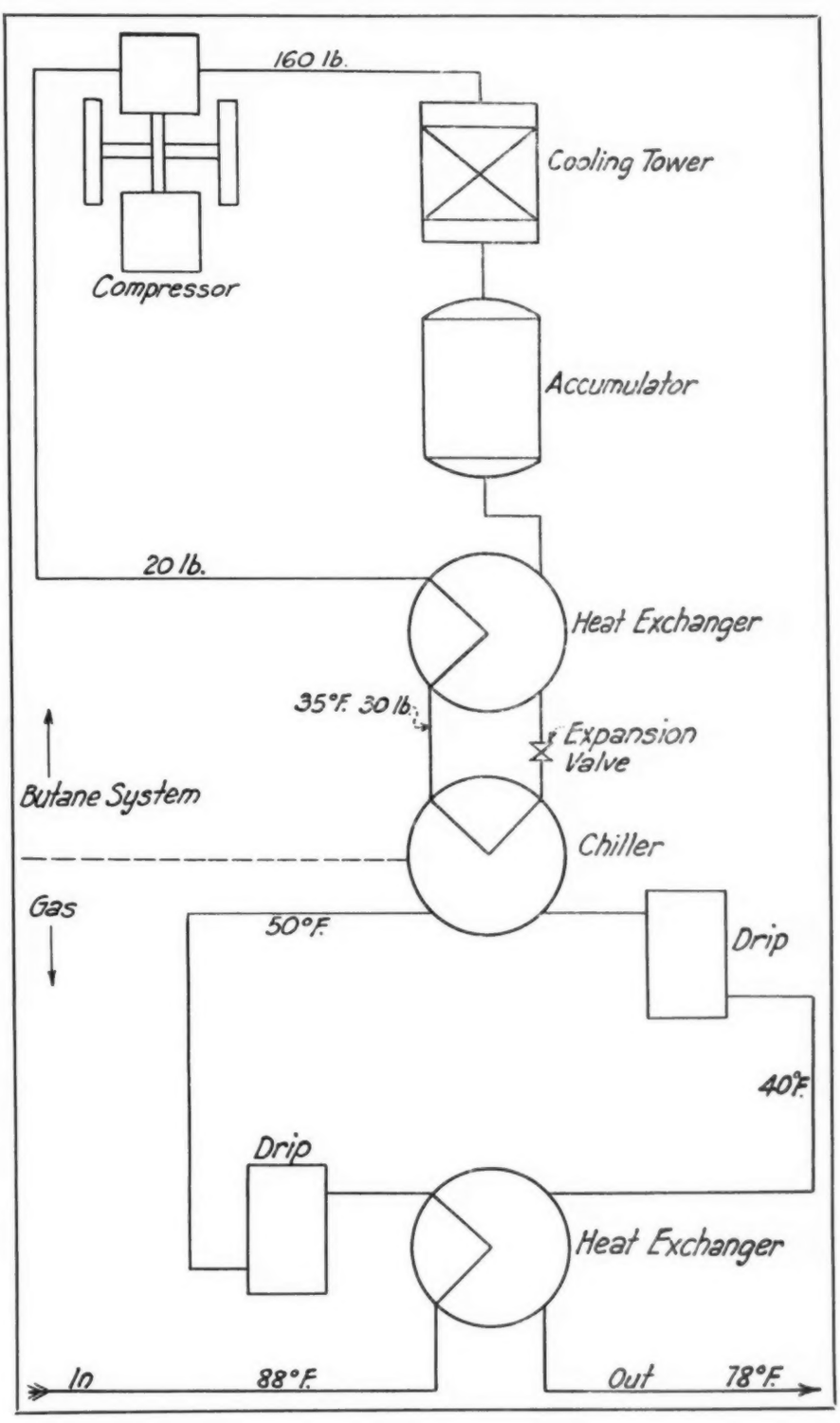


Fig. 3. Refrigeration plant

Influence of Controlled Cement Slurry Weights in Squeeze Jobs

A practical discussion of the application in squeeze jobs of cement slurry, whose weight is governed by conditions in the sand

By JACK BARNES[1]

ALTHOUGH cement squeeze jobs have been recognized as an invaluable asset in protecting productive sands in oil and gas wells, comparatively little has been mentioned or written on controlling the weight of the cement slurry and its influence on the degree of success of a squeeze job in a well, particularly since slow-setting portland cements are on the market. More and more squeeze jobs now are done by using a cement retainer, thus insuring greater accuracy in the placement of the cement. Most operators are thoroughly familiar with the actual operation of placing the retainer and the cementing process, so that phase of the operation will not be discussed.

Squeeze jobs are used to shut off water or gas by forcing cement slurry under pressure into the formation. It has been proved that the average formation to be cemented off acts as a screen for the cement slurry and that the penetration into the formation is very slight, unless through channels or fissures, if these exist. The weight of slurry to be used is indicated by the permeability, which may be determined from a core or by the pressure required to inject water into the formation. When the pressure is high, it is better to begin by pumping in a light slurry weighing about 12½ or 13 lb. per gal. in order that the free water in the slurry may carry some of the "fines" or "flower" of the cement with it into the formation to give support to the cement that is strained, or filtered, out to form a sheath on the face of the sand exposed in the hole. Though the ultimate quantity of cement on the face of the sand will be the same, prolonging the process of injection will allow the free water in the cement a better opportunity to carry some of the "fines" into the formation with it. In instances where the formation is very permeable or channeled a slurry of approximately 15 to 16 lb. should be used so as to insure the cement being deposited uniformly on the face of the sand in the hole or in channels in the formation. Where the channels in the formation are such that the formation will take an indefinite amount of cement, squeeze jobs may be—and have been—successfully completed by allowing the cement to stand at rest for a while in the formation so that it will become unpumpable; then mixing a light-weight slurry and pumping it into the formation under increased pressure. In this manner the cement will fill most of the channels. The unfilled channels remaining will be sufficient to make the formation tight or only slightly permeable thus causing the cement to be filtered out and form a sheath on the face of sand exposed in the hole.

The slow-setting portland cements now on the market allow the operator ample time to be certain that the cement is in place before it becomes unpumpable.

It has been found that in some areas where squeeze jobs have been done

[1]Petroleum Engineer — Trinity Portland Cement Company, Dallas.

Fig. 1. Thin sand and excessive water

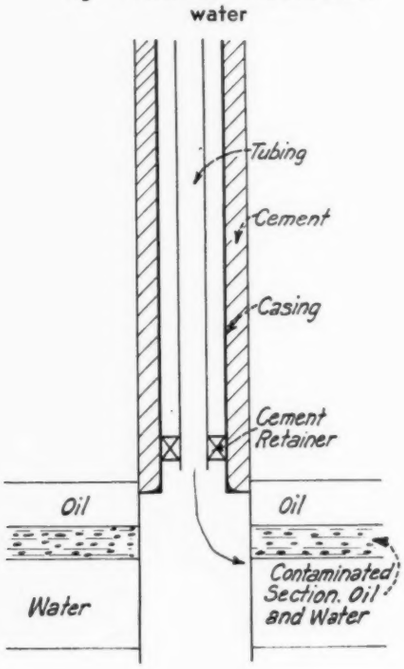


Fig. 2. Thick oil sand—amount of water does not affect

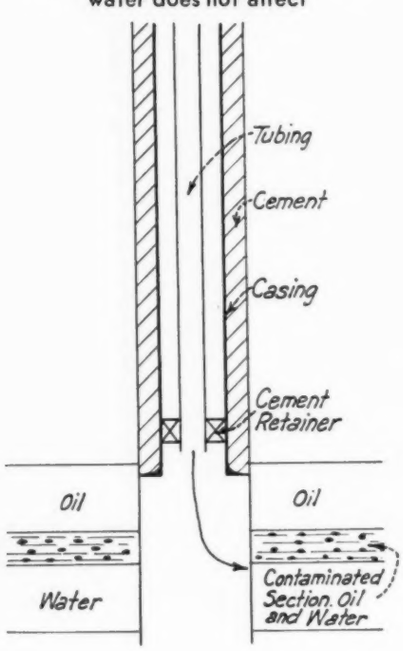
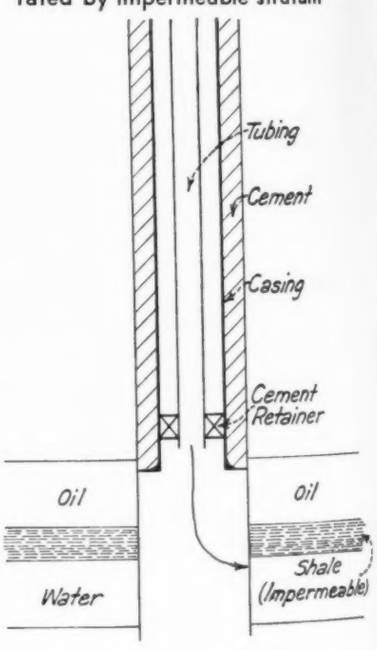


Fig. 3. Oil sand and water sand separated by impermeable stratum



through casing perforations that extend over a length of more than about five ft. of casing, the cement does not squeeze equally through each perforation. In such instances, the same procedure as used in loose, or very permeable, formation may be employed to good advantage, except that a lightweight slurry should be used and it will not be necessary to shut down until the cement becomes unpumpable. The cement, taking the path of least resistance, will accumulate first in the perforations that offer the least resistance; as the free water is squeezed out of the cement only 15 or 20 minutes shutdown will be necessary. The cement in the perforations that offer the greatest resistance still will be fluid and the process of squeezing will be repeated.

When squeeze jobs in open hole and not through perforations are contemplated, it is well to consider the thickness of the producing sand and the quantity of water "being made" by the well. Where the oil sand and water sand are in contact with each other and there is no definite boundary between them, the oil sand undoubtedly will be contaminated for a thickness of 18 in. or three ft., depending upon the permeability and the quantity of water produced. Water can be squeezed off successfully when it is in contact with a thin stratum (three ft. or less, see Fig. 1) provided the amount of water produced is comparatively small, without impairing the oil formation completely; but, should the amount of water produced be excessive, a straight tubing plug-back usually will be more successful.

When the oil sand is five ft. or more in thickness (see Fig. 2) squeeze jobs also have been successfully completed regardless of the amount of water produced, but it is to be assumed that about three ft. of the sand was squeezed off with the water sand.

When an impermeable formation exists between the oil and water sands (see Fig. 3) squeeze jobs have been successful regardless of the amount of water produced or the thickness of the oil sand.

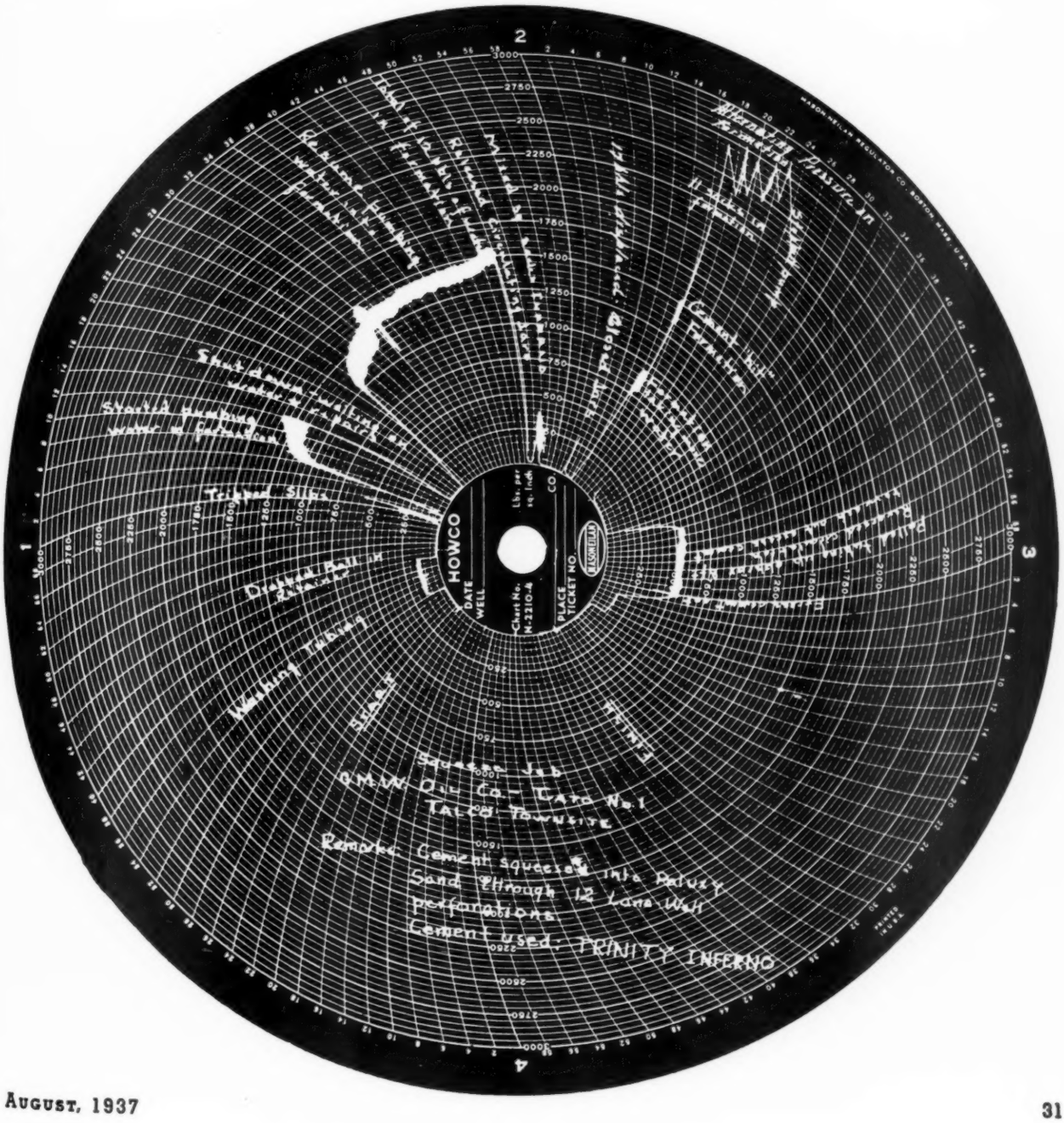


Fig. 4. Recording chart of a squeeze job in the Talco field, Texas. The chart is self-explanatory except that the slurry was mixed very light due to the tight formation

Nomograph for Estimating Future Production of Oilfields in Volumetric Control

Formula used in constructing nomograph relies upon certain assumptions relating to rates of flow in reservoir, status of producing wells, extent of structure as compared with actual producing area, and type of producing sand

By L. V. W. CLARK[1] and C. S. NEWEY[1]

IN general the production of a natural reservoir declines with time even if the production be termed the total amount of liquid, i. e., oil and water, produced per unit period of time. Several explanations have been brought forward in order to explain this phenomenon. Two of these are quoted:

1. The flow of the oil may be inhibited or eventually stopped by the formation of gas bubbles in the pores of the sand.

2. The head, hydrostatic or otherwise, producing the flow of oil from the sand, may decline as the contents of the reservoir are removed.

These two cases have been termed capillary and volumetric controls respectively by Herold,[1] who has mathematically investigated them. As the title of this article implies, capillary control in nowise will be discussed, the analysis being confined to volumetric control. It was desired to construct a nomograph from which, given certain data, the future performance of a field in volumetric control could be estimated approximately. Absolute accuracy could not be hoped for or expected owing to the continual variation of the number of wells actually producing, and their methods of production, during the normal life of the field.

The formula used for the construction of the nomograph relies upon certain assumptions that are tabulated herewith:

1. The rates of flow in the reservoir are so low that everywhere the liquid is in a state of streamline flow and the kinetic energy of the fluid may be neglected.

2. The number of producing wells has reached a constant value.

3. The extent of the structure is large as compared with the extent of the actual producing area.

4. The producing sand is reasonably homogeneous and horizontal.

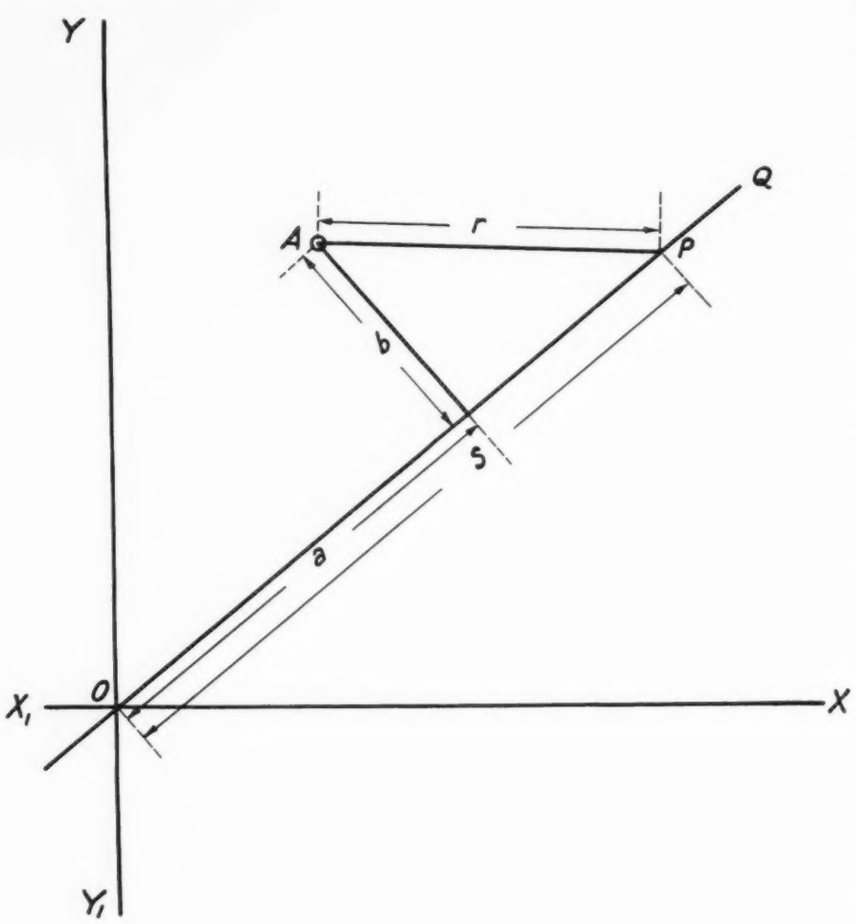
The first assumption implies that D'Arcy's Law controls the flow at all places within the reservoir. D'Arcy's Law may be stated thus:

$$\frac{dp}{ds} \propto V$$

where

$\frac{dp}{ds}$ = pressure gradient,

and V = velocity of flow of fluid.



A is the well. XOX_1 and YOY_1 are cartesian axes arbitrarily chosen to facilitate mathematical analysis.

[1]Department of Oil Engineering and Refining, University of Birmingham, England.

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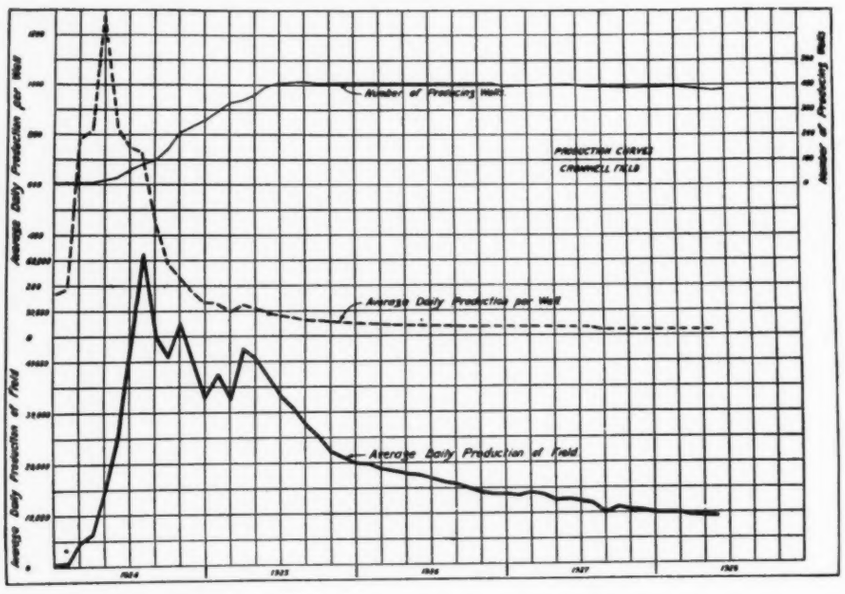

Fig. 2. Production curves, Cromwell, Oklahoma, field

Consider the well A in Fig. 1.

YOY_1 and XOX_1 are arbitrarily chosen cartesian axes. Point P is movable along OQ or , in other words, the quantity S is the variable.

The velocity at any point due to a producing well will always be directed towards that well and its value will vary inversely as the distance of the point from the well. This follows from simple geometrical principles and is in effect the principle of radial flow. Therefore, we may say that the velocity at P in the direction AP is given by:

$$V_{AP} \propto \frac{Q}{[(S-a)^2+b^2]^{\frac{1}{2}}}$$

where Q = the quantity produced by well A in unit period of time.

Resolving along OQ we obtain the following relation:

$$V_{OQ} \propto \frac{Q\,(S-a)}{(S-a)^2+b^2}$$

Consideration of other producing wells may be effected by the introduction of a summation sign.

$$V \propto \Sigma\left[\frac{Q(S-a)}{(S-a)^2+b^2}\right]$$

Substituting in D'Arcy's equation we have:

$$P = K\,\Sigma\int\left[Q\,\frac{(S-a)}{(S-a)^2+b^2}\right]ds$$

K = constant of proportionality.
Integration gives,

$$P = K\,\Sigma\frac{Q}{2}.\log_e[(S-a)^2+b^2]+C$$

Now allow the point considered to be situated distant from the producing wells A_1, A_2, A_3, etc. by r_1, r_2, r_3, etc.

Now $r_1^2 = [(S-a_1)^2 + B_1^2]$

Therefore,

$$\frac{1}{K}(P-C) = \Sigma\, Q \log_e r$$

$$\frac{1}{K}(P-C) = \log_e[r_1^{Q_1} r_2^{Q_2} r_3^{Q_3} \text{ etc.}]$$

Taking a point at maximum structure pressure we may state:

$r_1\ \Omega\ r_2\ \Omega \ldots\ldots r_n = r$

since the distance from this point to the producing area will be great in comparison with the distance across that area.

Therefore,

$$\frac{1}{K}(P-C) = (Q_1+Q_2+..Q_n)\ \log_e r$$

But where

$$Q_1+Q_2+Q_3+\ldots..Q_n = Q_T$$

Q_T = total production of the field per unit period of time.
i. e. $P-C \propto Q_T$

For hydraulic control P remains constant in magnitude and, therefore, so long as C is constant the production per unit period of time will not vary. In practice C decreases with the number of wells opened up and, therefore, a campaign of drilling will bring about increased production.

In volumetric control the time factor must be considered since the head producing flow is continually diminishing. For an analysis we require a relation between the fall of this head and some other quantity. This relation is supplied by the law of equal production per lb. decline. A mathematical statement of this law is given:

$$P = a - b \cdot V_o$$

a and b are constants.

V_o = actual volume of liquid that has been produced.

This formula may be made more general by assuming that the hydrostatic head is being replaced at a continual rate and by making the necessary modifications.

We now have:

$$P = a - b \cdot V_o + b \cdot c \cdot T$$

T = time elapsed from the beginning of production.

c = actual rate of replenishment.

Differentiating:

$$dP = -b\,Q_T \cdot dT + b \cdot c \cdot dT$$

Substituting for Q_T,

$$\frac{dP}{p\,(P-C)-c} = -b \cdot dT$$

Integrating and rearranging:

$$Q_T - c = q \cdot \gamma^{-T}$$

Q_T = production per unit period of time.

T = time elapsed from any arbitrary moment.

c, q, and γ = constants fixed by the performance of the reservoir.

p = a constant of proportionality.

Theoretically this formula applies only to a reservoir containing a fluid in one phase, that phase being liquid; however, Gardescu[2] has stated that as the oil moves through a reservoir containing both oil and gas, the bubbles of gas remain stationary because of their resistance to distortion and the relatively small pressure gradient. This means that the flow of the oil follows the general laws for dead fluids as the presence of the gas bubbles only alters the apparent permeability of the rock. Further evidence of this is given by Owen,[3] who by the study of empirical data arrived at a similar formula. Further evidence is afforded by the application of the formula in practice.

Instructions for the Use of the Nomograph

The nomograph was constructed according to the usual principles of simple nomography. On the other hand there are several novel features that make a complete explanation of its use necessary. The manipulation of the nomograph is explained by a hypothetical example while two actual practical applications of the nomograph are given subsequently.

In the first place a suitable unit for time should be selected. This should lie approximately within the range 2-12 months. Secondly, three points on the

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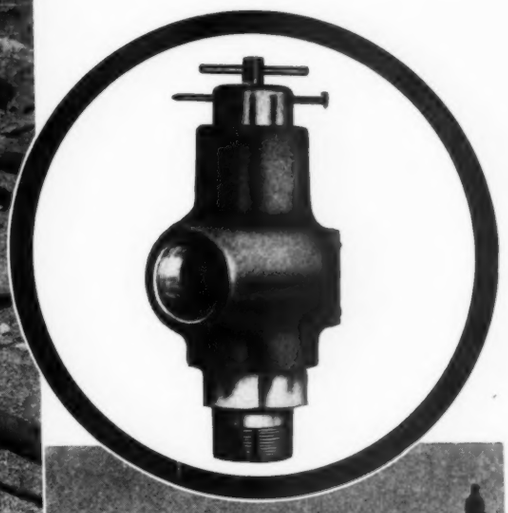

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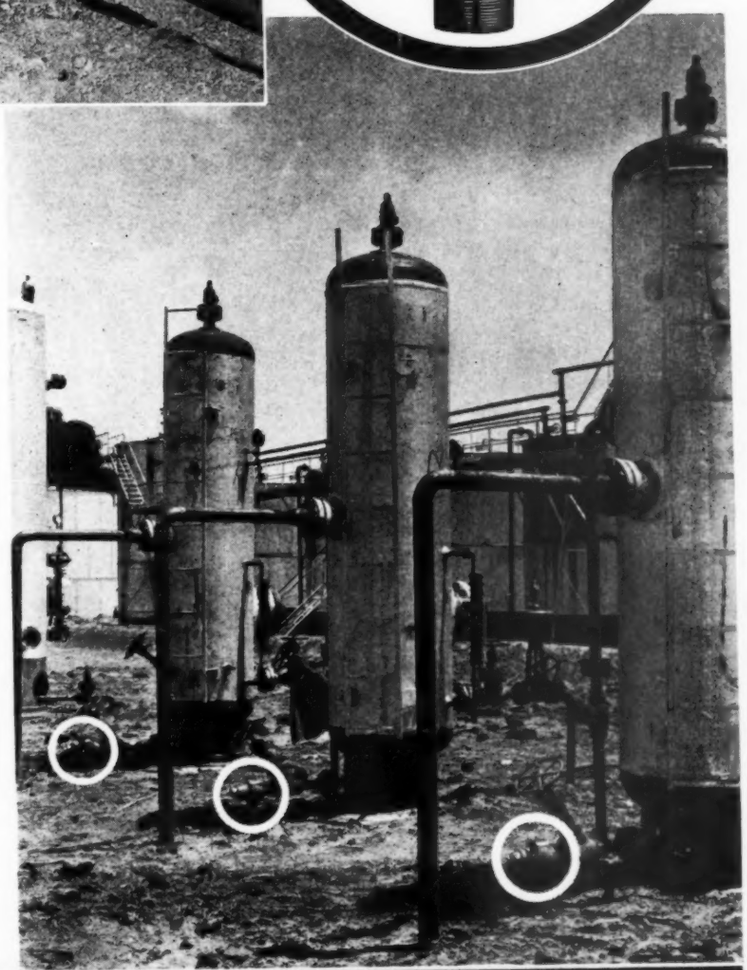
Note (above) SHEAR-RELIEF Valves near well location, and (right) near separator input. Inset shows simplicity of the SHEAR-RELIEF Valve.



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production curve must be selected so that they are separated by unit periods of time. Care should be taken to use a portion of the curve that shows settled production, during and after which the number of producing wells remains practically constant to within a few percent.

These points should be tabulated thus:

$$T_1 = 1 \quad Q_1 = 60{,}000$$
$$T_2 = 2 \quad Q_2 = 40{,}000$$
$$T_3 = 3 \quad Q_3 = 30{,}000$$

Now:

$$\gamma = \frac{Q_1 - Q_2}{Q_2 - Q_3} = 2$$

$$q = \frac{(Q_1 - Q_2)^3}{(Q_1 - 2Q_2 + Q_3)(Q_2 - Q_3)} = 80{,}000$$

$$c = \frac{Q_1 Q_3 - Q_2^2}{Q_1 - 2Q_2 + Q_3} = 20{,}000$$

Erect a perpendicular from the point where γ is equal to 2 on the horizontal scale of the nomograph. Measure off $q = 8$ on the right hand scale and join by a straight line to the point $T = 0$, i.e., the left-hand bottom corner of the nomograph. The point at which this line cuts the perpendicular should be clearly marked as the point P_o. This point P_o will not be sufficient to cover the whole period of production and further points should be obtained in the following manner. Join the right-hand bottom corner to the point P_o and continue with a straight edge to the intersection on the time axis. Join this point of intersection to the mark opposite 10 on the Q_T-c axis and where this line cuts the vertical from the calculated γ, mark as point P_1. Similarly a point P_2 may be obtained from point P_1 and so on. In general not more than three of these points will be required.

The nomograph is now ready for application to the particular field under consideration. Let us suppose that the production is required for a moment exactly seven units of time after the first point chosen on the production curve. The value of T to be used on the nomograph is now $7 + 1$, i.e., 8, owing to the method in which the values of the constants were calculated. For clearness it should be remembered that to calculate T this formula must be used:

$$T = \frac{\text{Time elapsed in mos. from } T_1}{\text{No. mos. in unit period time}} + 1$$

Now join the point $T = 8$ to the suitable point P (in this case P_2) to give an intersection with the right-hand axis. This value is read off and its method of reduction to a value for Q_T is given by the following explanation:

1. Express q in the form shown, i.e.,
$$q = 80{,}000 = 8 \times 10^4$$

2. A time has been chosen and a corresponding value for $(Q_T - c)$ has been read off. The value in this case is 2.9.

Then if point P_o has been used,
$$Q_T = 2.9 \times 10^4 \times 10^{-0} + c = 29{,}000 + c$$

But if point P_1 is used
$$Q_T = 2.9 \times 10^4 \times 10^{-1} + c = 2{,}900 + c$$
and so on for P_2, P_3, etc.

In the example given, point P_2 was used and, therefore,
$$Q_T = 2.9 \times 10^4 \times 10^{-2} + 20{,}000 = 20{,}290$$

Obviously the nomograph may be used in the opposite direction, i.e., given a definite production to find the time at which it may be expected. In order to show the application of the nomograph two actual instances of its use are given here.

Cromwell Field, Oklahoma.[4] From Fig. 2 it may be seen that the number of producing wells in the Cromwell field remained practically constant at about the value 400 after June, 1925.

Allowing time for production to settle, the first point taken was that for the beginning of the year 1926. The unit period of time selected was that of eight months. From the graph we may tabulate:

T	1	2	3
Q_T bbl./day	20,000	16,000	13,000

These give, $\gamma = 1.33$
$q = 21{,}333$
$c = 4{,}000$

The points P_o, P_1, and P_2 were constructed on the nomograph in the manner previously described.

The production in bbl./day is required for October, 1935.

$$T = \frac{118}{8} + 1 = 15.75$$

The use of the point P_2 gives the value 2.3 for $Q_T - c$, i.e., predicted production $= 2.3 \times 10^4 \times 10^{-2} + 4000 = 4230$ bbl./day.

The actual production[5] of the Cromwell field was 4225 bbl./day.

Naval Petroleum Reserve No. 3, Wyoming.[6] In this field there were

(Continued on Page 40)

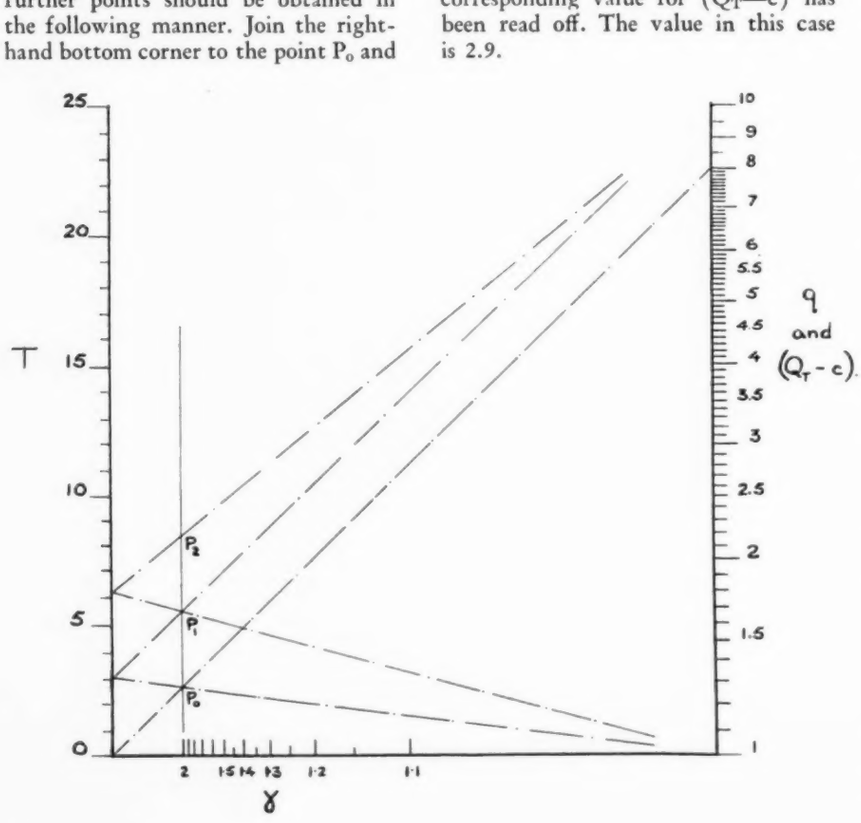

Fig. 3. Nomograph used in estimating future production of oilfields in volumetric control

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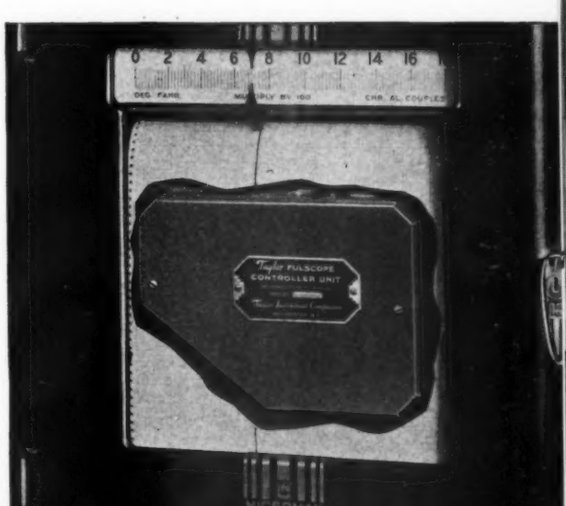

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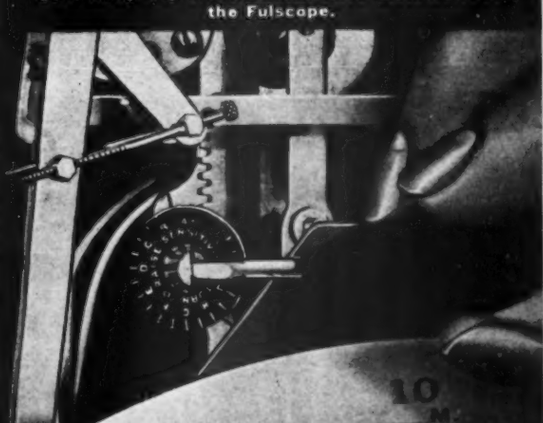

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(Continued from page 36)

three main producing horizons, of which those wells in the shale horizon are treated here.

On the same considerations as for the Cromwell field the following data were selected for the calculation of the constants necessary for the use of the nomograph:

Date	*Production in bbl./month*
April, 1925	7250
August, 1925	6700
December, 1925	6200

These data gave as values for the constants the appended results

$\gamma = 1.1$

$q = 6650$

$c = 1200$

Unit period of time = 4 months.

Productions predicted by the nomograph and the actual productions obtained are compared in the following table:

Date	*Actual Production**	*Predicted Production**
April, 1926	5600	5750
August	5300	5330
December	4600	4900
April, 1927	4300	4620
August	4200	4300
December	4000	4020

*bbl./month.

This method of estimating future production, besides the attractiveness of giving consistently good results, has the advantage over other methods and production charts of a theoretical basis in the reservoir itself.

Failure of the method may be explained by:

1. The opening or closing of a considerable number of wells.
2. By estimating the oil and not the oil and water production.
3. By edgewater encroachment closing down wells, although if as many wells are being opened up farther up dip as are being closed by the encroachment, the nomograph will still hold good.
4. By an extremely sudden change of production methods.

The scale on the nomograph has been drawn for a maximum value of γ of 2. This has been done merely to cover the conditions of the two examples chosen in which γ has values of 1.33 and 1.1. The volume rate-time curve for wells in volumetric control is hyperbolic and hence γ may have values greatly in excess of 2. Where the value of γ is greater than 2 the γ scale must be extended but it must be remembered that the initial value of γ will be a maximum and for future calculations it will in every case be smaller than this.

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[1]*Herold:* "Analytical Principles of the Production of Oil, Gas and Water from Wells."

[2]*Gardescu:* "The Behavior of Occluded Gas in an Oil Sand Reservoir." *The Petroleum Engineer*, Vol. IV, No. 5, pp. 2, 3, 4, and 5; November, 1932-February, 1933.

[3]*Owen:* "Empirical Formulae for the Production Curves of Oil from Wells." J.I.P.T., Vol. 17, 1931, p. 501.

[4]*Langworthy:* "Cromwell Field, Oklahoma. Structure of Typical American Oilfields." Vol. II, p. 312.

[5]*Oil and Gas Journal*, October 17, 1935, p. 73.

[6]*Thom and Spieker:* "The Significance of Geological Conditions in Naval Petroleum Reserve No. 3, Wyoming." U. S. Department of the Interior, Geological Survey Professional Paper 163, Plate 23.

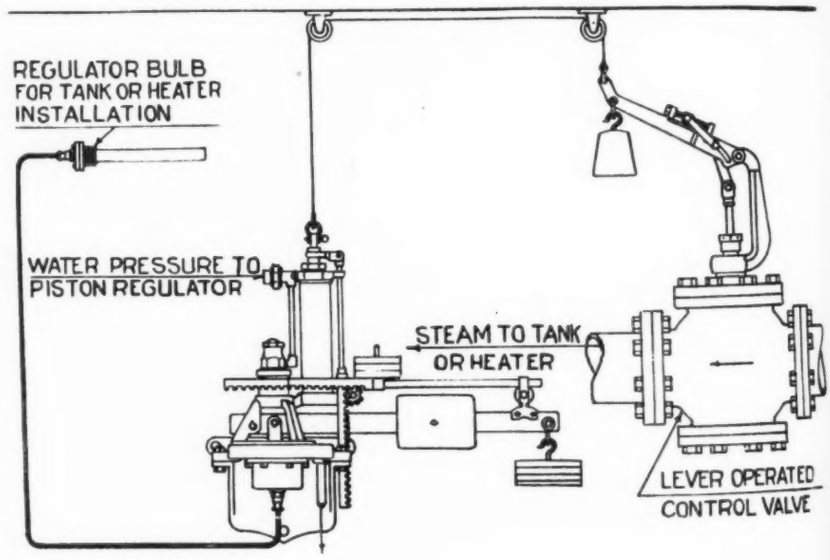
Dependable Temperature Control in Refineries

By W. F. SCHAPHORST

A QUESTION commonly asked by refinery operators is: "How can we control valves, dampers, and other regulating devices automatically through small change in temperature?"

The accompanying sketch shows an excellent manner in which to accomplish this. The "regulator bulb" at the left is placed in the tank, heater, or gas passage to be regulated. It transmits a slight force to the intermediate regulating device shown in the center. Then by means of water pressure from the city main or elsewhere this central device, which is "touched off" by the slight pressure change, gives the necessary force through the cable to operate a large valve, damper, or gate without any human aid whatever. It works backwards as well as forwards, the counterweight doing the closing.

Take for example the large lever-operated control valve shown in this sketch. Attempts to handle steam valves as large as 8-in. by temperature regulation alone, without the aid of water or air pressure, usually result unsatisfactorily. An intermediate power device, such as employed here, generally is advisable. It may be necessary to develop a special opening and closing lever like the one used on this valve, but it usually *can be done*. The arrangement as sketched operates very well. It is a dependable method that assures automatic temperature regulation within close limits.



The Petroleum Industry in South America

Wallace A. Sawdon

Wallace A Sawdon, contributing editor on the Pacific Coast for THE PETROLEUM ENGINEER, recently returned from a trip of more than 12,000 miles through South American oil fileds. Traveling principally by air, he was able within a period of two months to make first-hand observations of the operations involved in developing, producing, refining, and transporting petroleum in Trinidad, Venezuela, Colombia, Ecuador, and Peru. These observations he has recorded in the following series of articles.

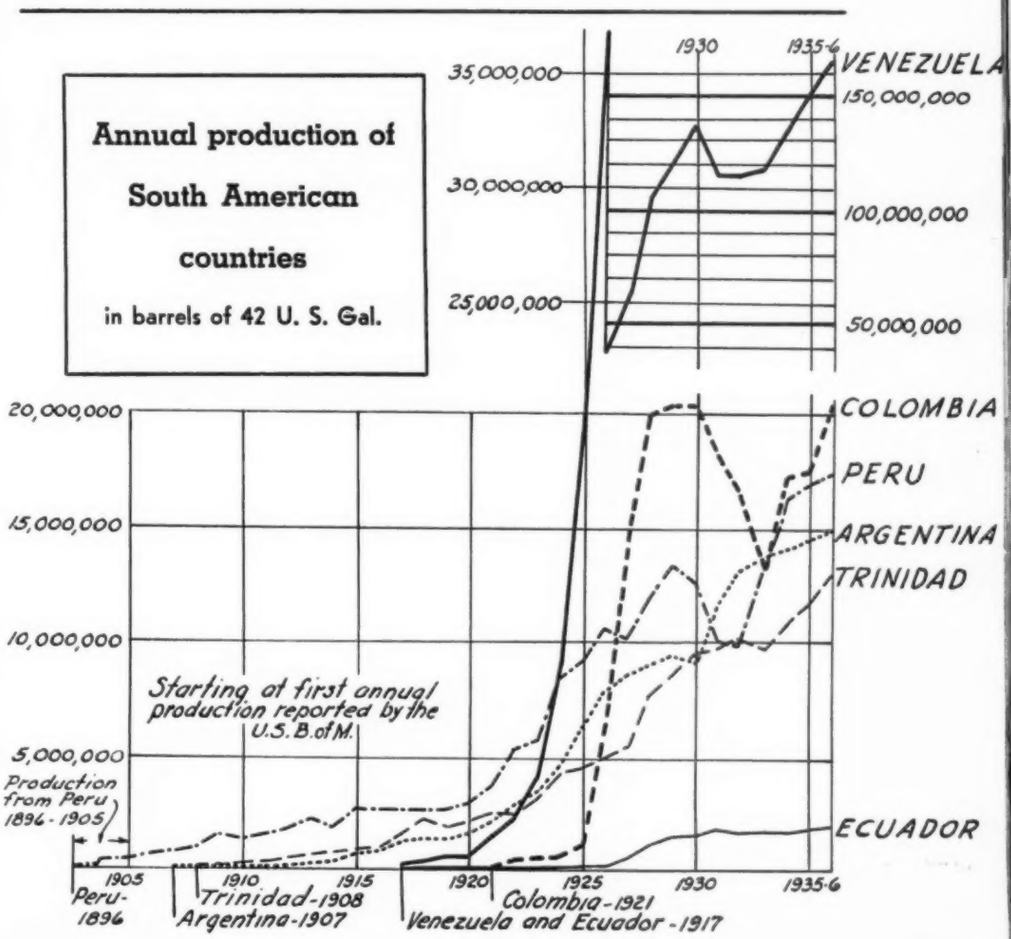
Mr. Sawdon's training and experience of more than twenty years as an engineer and as a technical writer on petroleum engineering and related subjects lends added value to his observations. He has uncovered a wealth of facts that command the attention and interest of our readers.

The section covering the petroleum industry in the Argentine Republic was prepared specially for this issue by the staff of Yacimientos Petroleiferos Fiscales, or Y. P. F., better known in this country as the Argentine Government Oilfields.

NO MERE statement of statistics can convey an adequate picture of the magnitude of oil operations in South America. Local conditions present difficulties to be overcome that necessitate oil companies engaging in subsidiary industries that range from the operation of brick plants to the building and running of railroads. An elaborate water-supply system that will include complete treating plants and long pipe lines usually is essential; extensive stocks must be carried, so that tools, machinery and supplies will be immediately available; handicaps of climate and rugged topography must be surmounted. Despite these difficulties operations are being conducted with a high degree of efficiency and by employing the most modern methods. In fact, the control of production to obtain the greatest present and ultimate yields probably is more advanced than in many fields in the United States. The fact that operations are not influenced by multiple ownerships of surface holdings only accentuates the desirability for unit control of any oil pool.

All activities are directed and supervised by the foreign staffs of the companies operating the fields. Practically all other employees, however, are natives of the countries in which the fields and plants are situated. Many of the drillers and nearly all foremen are South Americans who have been trained by the companies. Sanitary camps have been erected and provided for these employees; and medical attention, hospital facilities, and the excellent food supply have greatly improved the health of the employees and their families.

The data from which the following articles were complied were procured through the coöperation of the various oil companies operating in South America. The author gratefully acknowledges this coöperation without which authentic material could never have been obtained.

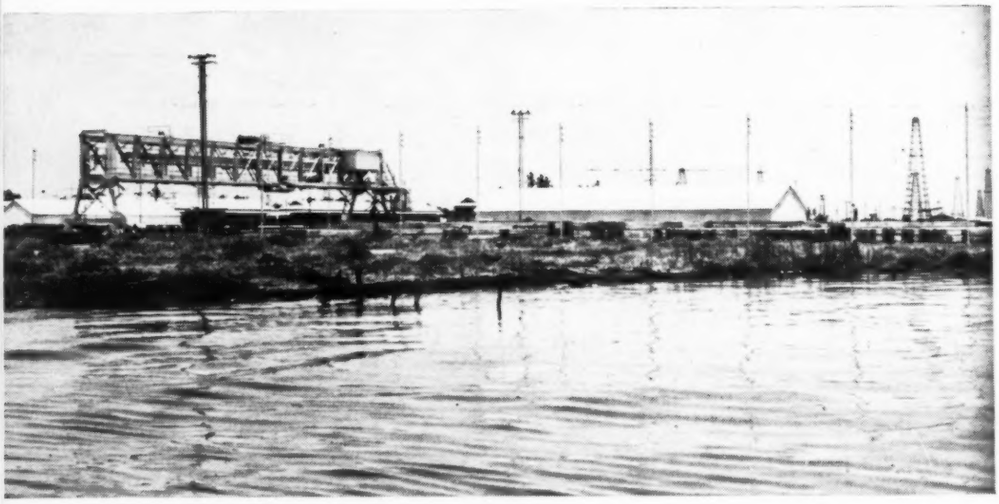


The steady increase in production of all countries in South America now actively producing oil is shown on the chart to the right. Of the fields supplying the greatest portion of this oil, none has been completely drilled up. With the discovery of new fields—which especially can be expected in Venezuela—and the extension of old ones, further increases in production can be considered probable. Geophysics is becoming a vital factor in exploratory work and should aid materially in expanding producing territory. Deep wells of from 8,000 to 10,000 ft. have not yet been drilled, but deep drilling probably will come when the necessity arises.

Lake Maracaibo Operations . . . As Told by Camera

This pictorial record of operations on Lake Maracaibo is given in sequence to show how special equipment has been designed and applied to meet the unusual conditions encountered in drilling and producing an extensive productive area that lies entirely beneath water. The organization and methods developed have perfected a technique that has been extremely effective in drilling and producing wells at a distance of almost five miles from shore and in water that sometimes exceeds 60 ft. in depth. As the present-developed areas extend for a distance of more than 30 miles along the shore of the Lake, the magnitude of the operations thus is obvious.

Only pictures of the Lake operations of the Lago Petroleum Corporation are shown here. More details on the fields and methods used by this and other companies, as well as additional illustrations are given in the article, "Maracaibo Lake Fields Remain a Big Factor in Venezuela's Production."

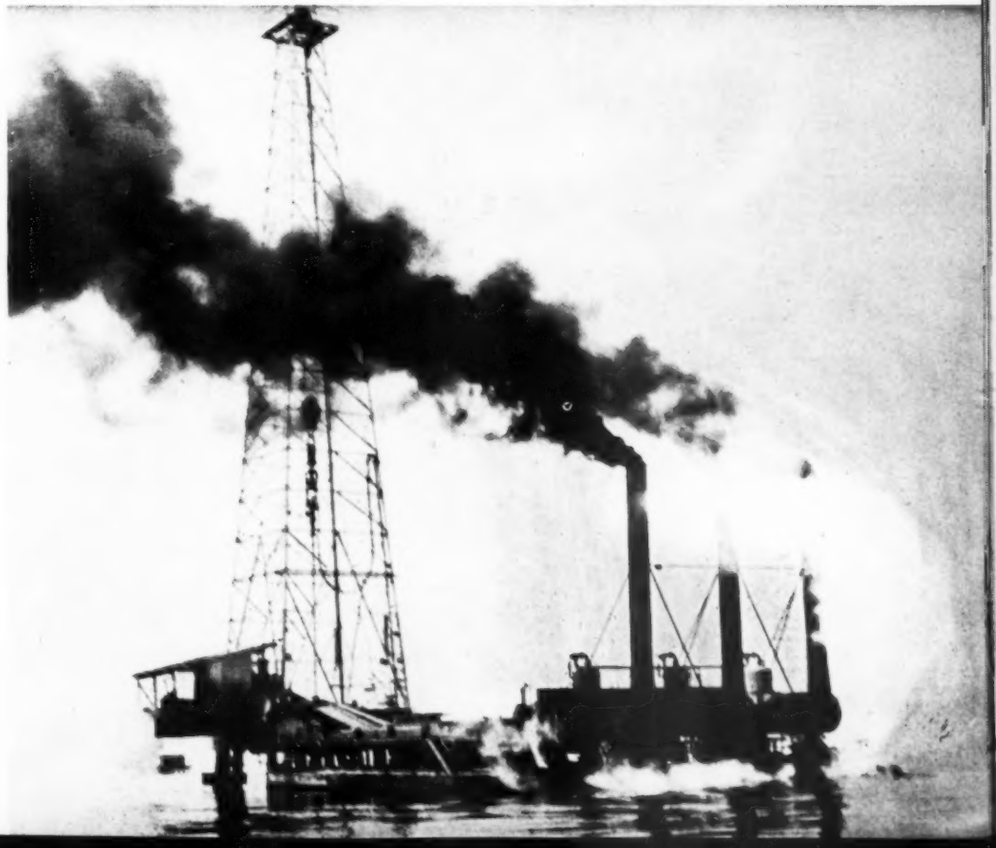


1. Drilling and producing operations conducted on Lake Maracaibo necessitate a considerable amount of construction work before a well can be drilled, as well as preparatory to the setting of tanks and separators, or building compressor stations and gasoline plants. This begins with the manufacture of reinforced concrete piles, which is done in a plant at La Salina. The piles are made to specifications determined by a test pile driven at a location before it is to be utilized.

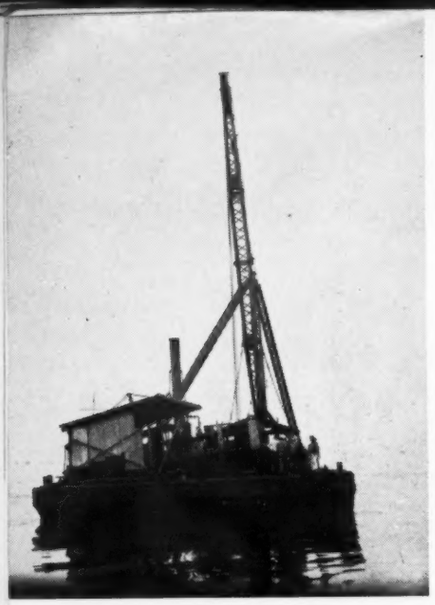
2. When the substructure of a drilling operation is to be constructed the piles are transported to the location on a barge. Each location is supplied with piles cast especially for the depth of water and character of formation to be penetrated as well as to meet conditions imposed by the type of structure.

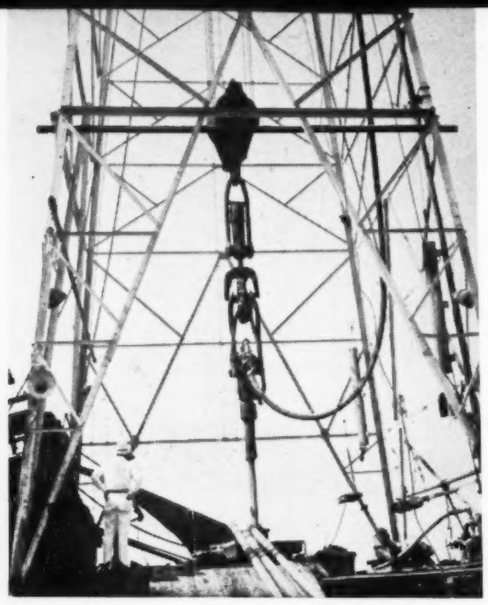
3. The pile-driving equipment is complete in every detail and is mounted on a barge equipped with a 110-ft. boom. Movement of the barge is controlled from an anchor line with a steam hoist. Steam power is used and is supplied by three boilers. The next step is to drive the pile into place with a pile driver. Here the pile driver has just completed driving piles for a well in the Lagunillas field.

4. The derrick is erected after the piles are stripped to their proper elevation and a rod-reinforced concrete cap poured on them to take a steel base. This photograph shows a derrick being erected for a well in the La Rosa field. A wooden flooring is placed on the steel base which, in the new designs, is extended as a cantilever beyond the piles on two sides. (See also photograph 14.) With the derrick completed, the steam engine, drawworks, and table are moved on and the well rigged up ready for drilling.



5. The drilling barge is moved up to the derrick and anchored at its four corners with its forward end parallel to the side of the derrick floor as shown in this picture of a drilling well in the Punta Benitez field. On the stern of the drilling barge are placed the boilers supplying steam to the engine and mud pumps. Just ahead of them are the pumps themselves. The engine is in the house overhanging the piling to the left. The barge is kept in position by adjustment of the anchor ropes and its upper deck is connected with the derrick floor by a bridge of planks that forms a ramp over which pipe and other materials are transferred from the barge to the derrick floor.

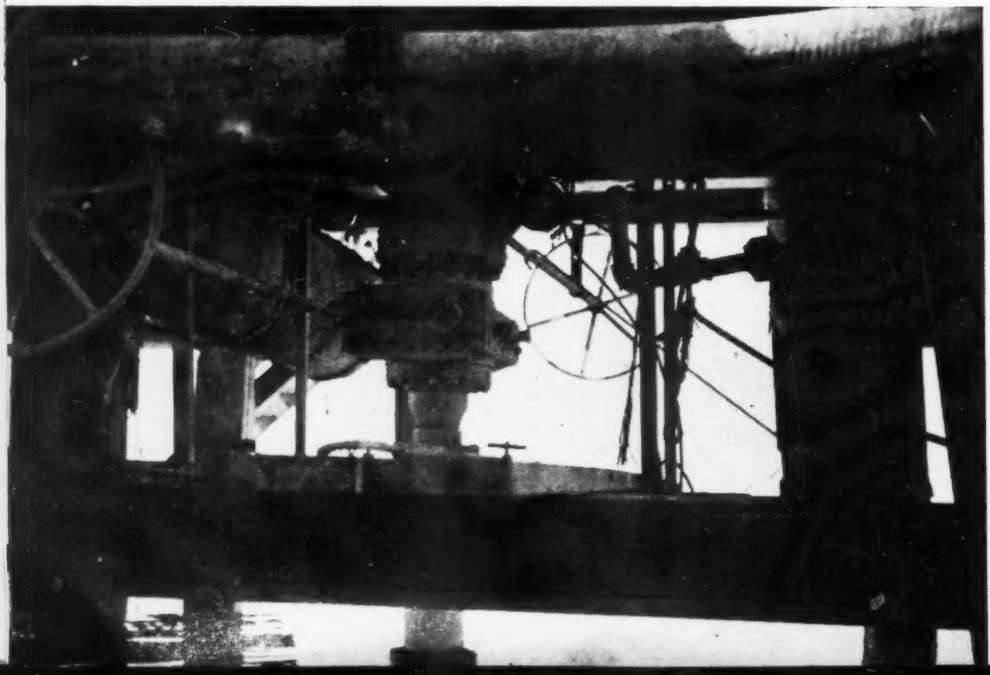




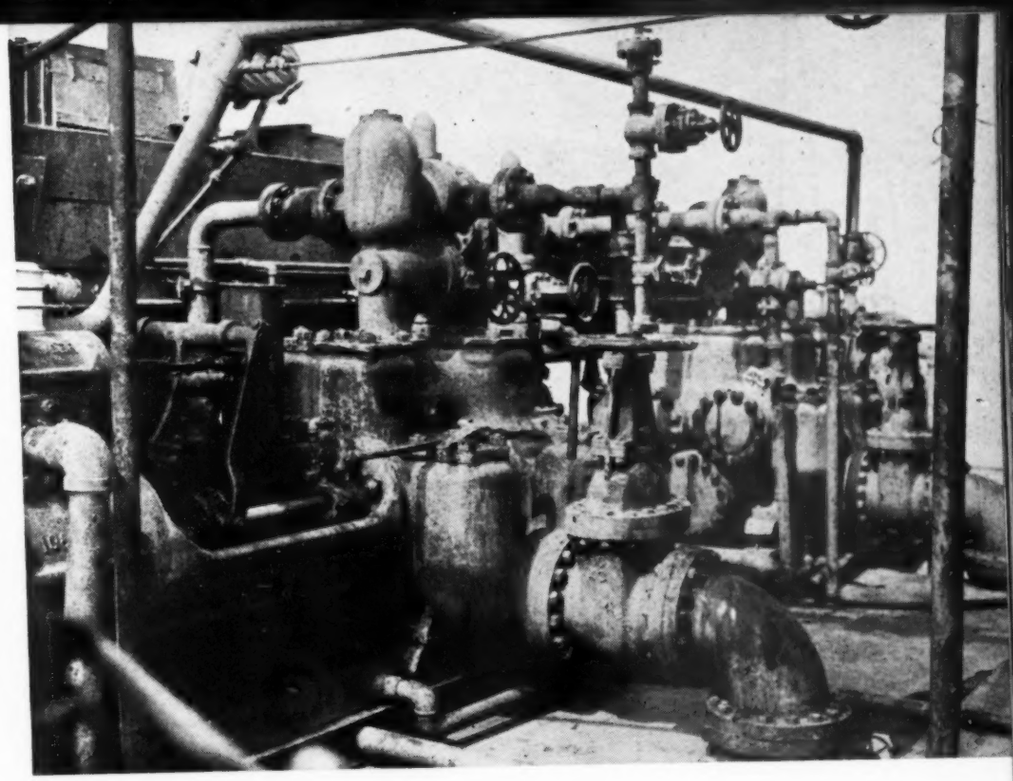
6. (Left) Heavy equipment, such as drawworks, are transported to the location by a derrick barge. In this photograph the derrick barge is shown transporting a drawworks to a new location.

7. (Right) Drill pipe and casing are kept on the deck of the drilling barge, which is connected to the derrick floor by a ramp, as can be seen in both (7) and (8). This photograph shows a hole being finished up preparatory to running 6⅝-in. combination liner.

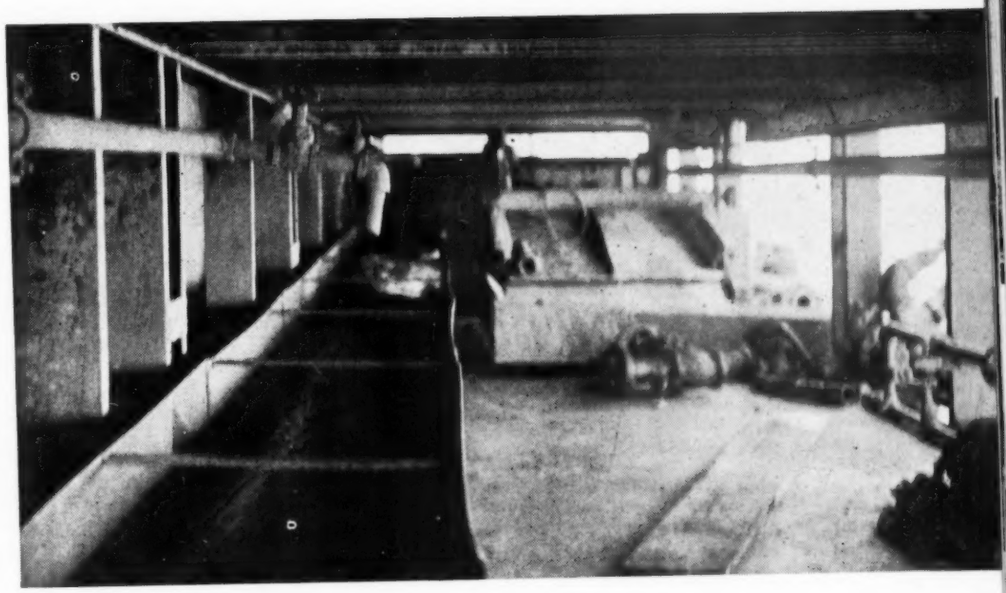
8. Here is shown the forward edge of the drilling barge in position during drilling operations. The ends of drill pipe and casing can be seen where they are kept on the upper deck of the barge available for use. Drill pipe joints ready for insertion into the drilling string are lying on the ramp shown to the left. Steam and mud are carried from the barge to the well and mud returns conducted back to the barge through the lines, which can be clearly seen in the picture. The mud-settling ditch is below the deck on which the pipe is stored as shown in photograph No. 11. Note the solid construction of the well structure with the reinforced cap on the concrete piles and the steel base supporting the derrick floor. Every convenience found on land operations is supplied for these wells, which are individual island operations during drilling and well-constructed producing units after completion. The extension to the right will eventually support a pumping unit.



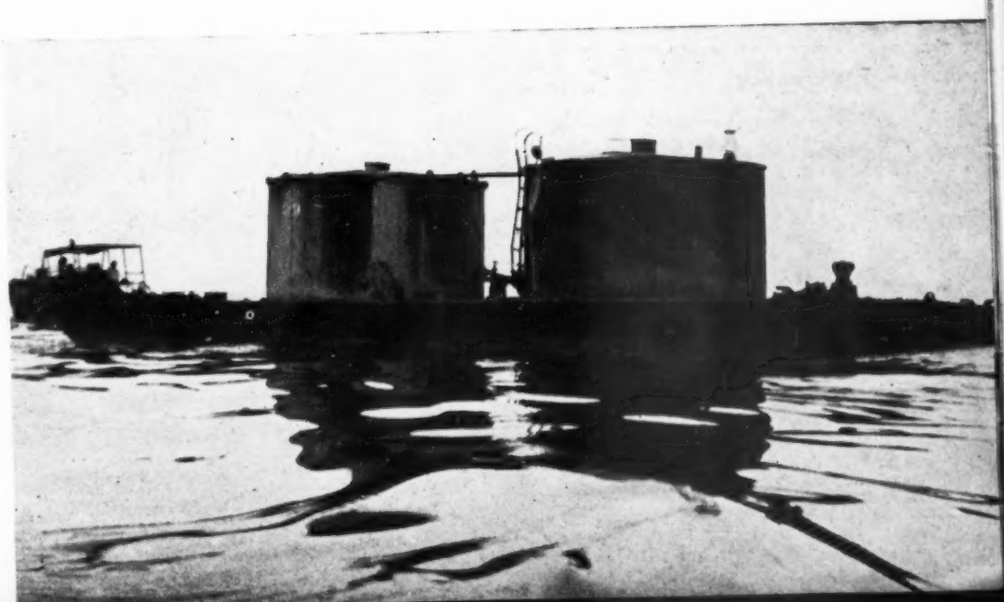
9. The cellar of wells drilled on Lake Maracaibo is naturally the space between the derrick floor and the water. The present practice in drilling wells is to equip them with a cellar control gate above which is placed a blowout preventer. Both the control gate and blowout preventer are operated by hand wheels, which can be seen at each side of the derrick substructure and which thus facilitate control of the well.



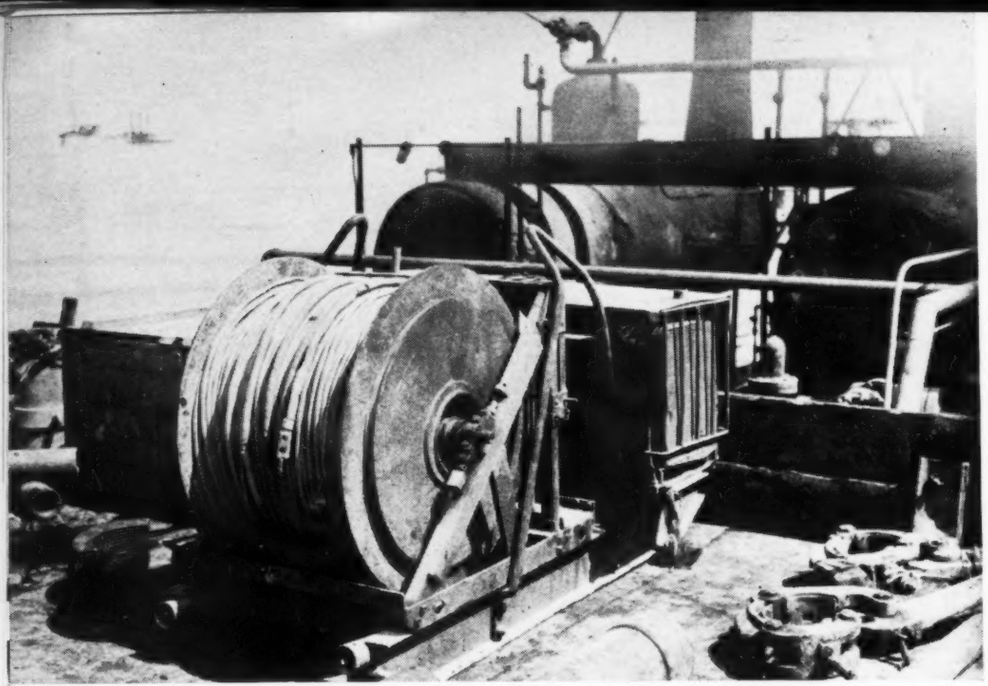
10. Two mud pumps circulate the mud fluid for drilling wells on the Lake from their position just in front of the boilers at the stern of the drilling barge. The pumps are below the level of the upper deck of the barge and are thus below the derrick floor of the well. Returns from the well are carried through the ditch shown in photograph No. 11 and flow into a sump built in the barge below the suction end of the pumps. The discharge is pumped through pipe to the forward end of the barge and there carried over to the derrick floor as shown in photograph No. 8.



11. Mud returns pass through a large-diameter hose and flow down the settling ditch, which is below the deck of the drilling barge. At the right in this photograph can be seen the vibrating screen, and at the left of the ditch are the fuel oil and mud compartments. The mud storage provided on the barge facilitates replenishing the mud stream as fresh mud is needed during drilling operations. The mud weight is usually held at about 81 lb. per cu. ft. but in some instances is increased to more than 90 pounds. The vibrating screen can be put in or taken out of the stream as desired.



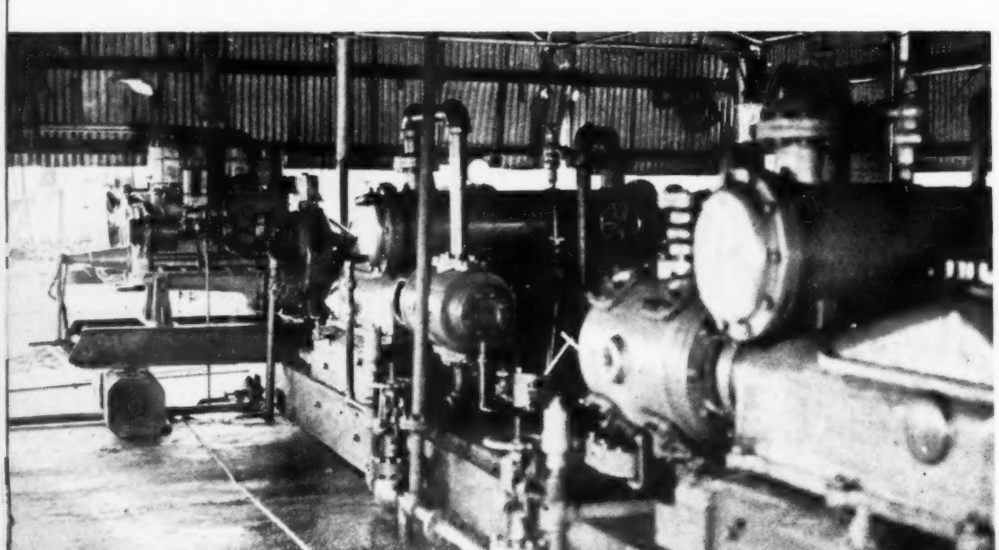
12. Mud is carried to the drilling operations by the mud barge, which is equipped with two 250-bbl. tanks. Spent mud usually is dumped into the lake, but when it may contaminate the water it is taken back on the mud barge for disposal on land. The mud supply is prepared at a mixing plant on land and is piped to the barges at a short pier at Lagunillas.



13. All wells are logged electrically and equipment for this purpose is brought to the well on a motor barge when the hole is ready. It is made in a unit on skids and swung up on the deck of the drilling barge and placed in position for making the logging survey. The electrical-logging equipment here is shown in position for running in a well that is just being drilled through the producing sand. Correlations of the fields made from the electrical logs are kept up to the minute and provide valuable data that are used to assist in the efficient practice being followed.

14. (Left) As soon as a well is completed it is placed on production. Here is shown a well at Punta Benitez with oil and gas going to a flow station for separation. The latest type of steel base with cantilever extensions on two sides is evident. On one side a pumping unit can be installed in the future when the well stops flowing. On the opposite side adequate room is available for any necessary operations without interfering with the pumping unit.

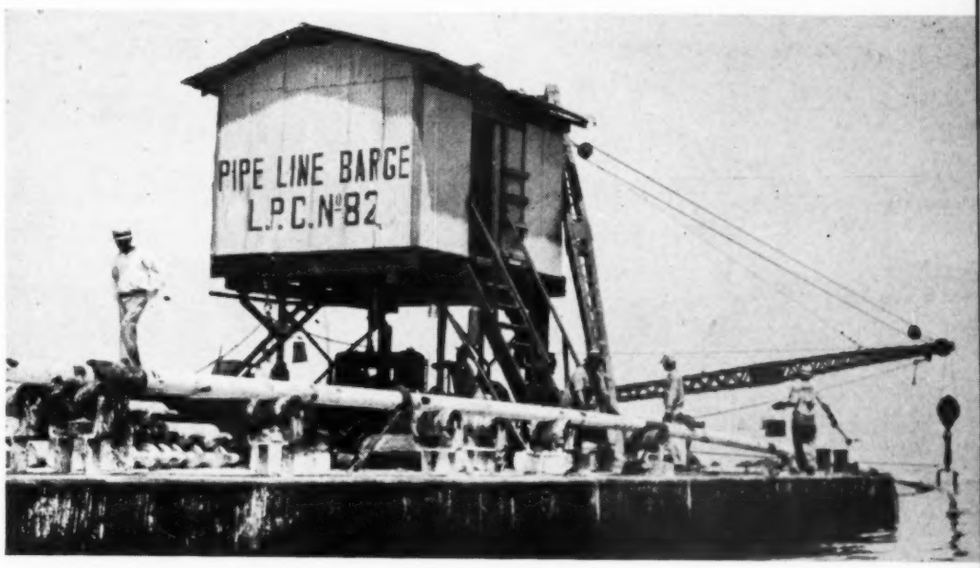
15. (Right) This well at Lagunillas flows directly into a high-pressure separator, where gas is taken off at a pressure of 450 lb. per sq. in. and put directly into the gas-lift system. The oil goes to the flow station, where the remainder of the gas is taken off.



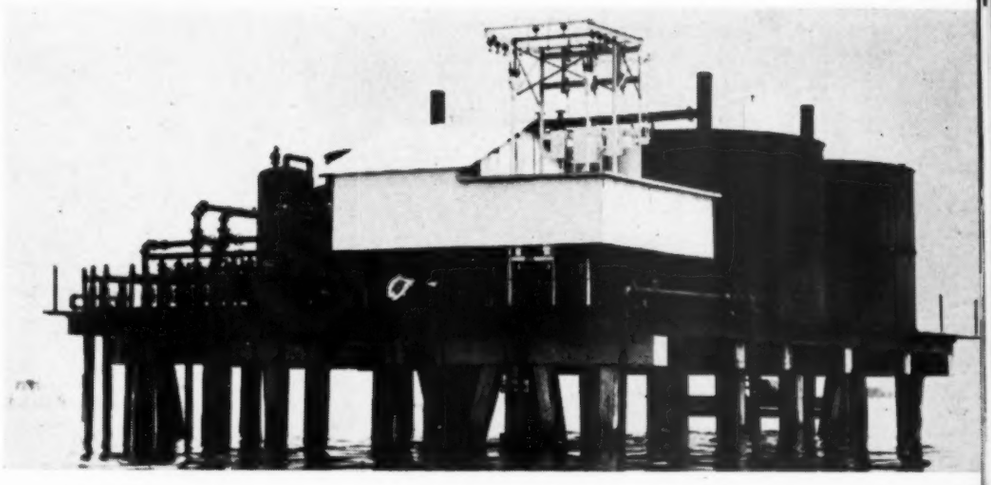
16. When it is necessary to start a well on gas-lift or kick-back a well that has died, a barge with compressors is brought up to the location to serve this purpose. On the barge shown here are two compressors, each driven by 100-hp. engines. This equipment is also available for any special purpose that may require the use of compressed air on any of the operations on the Lake.

17. Wells that do not flow are produced with individual pumping units. Several types of pumping units are employed and are set up on the derrick floor as shown here. With the new type construction shown in photograph 14, better facilities for setting the pumping unit are provided.

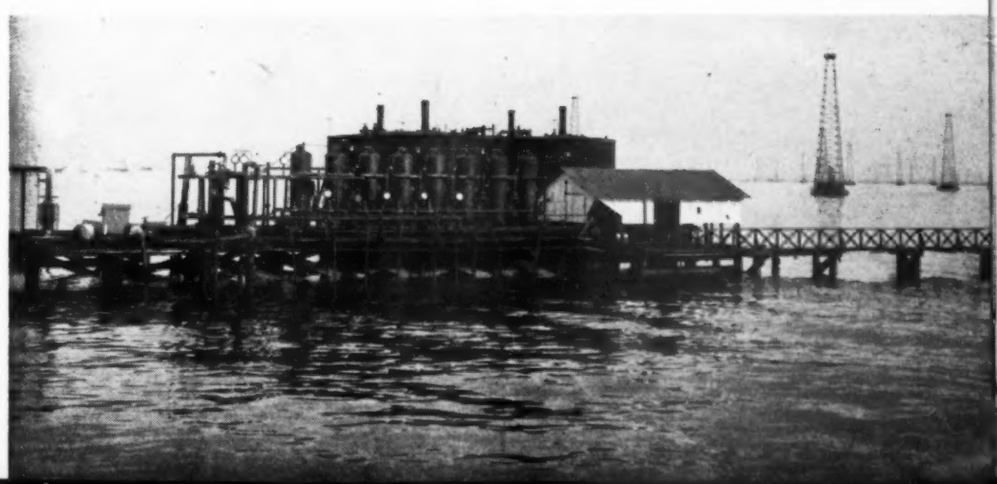
18. When a well is ready to go on production, the line from the location to the flow station is laid on the lake bed. In laying a line from a well to a flow station the pipe is made up in 80-ft. lengths and treated with enamel on shore. Two sections are welded together on the barge and the end welded to the line already laid. The pipe is handled as shown, with the barge being pulled ahead with anchors or pushed along by means of the pipe, like poling. The boom is equipped with a stirrup that has rollers for the pipe to run on and lowers the line carefully to the bottom of the lake.

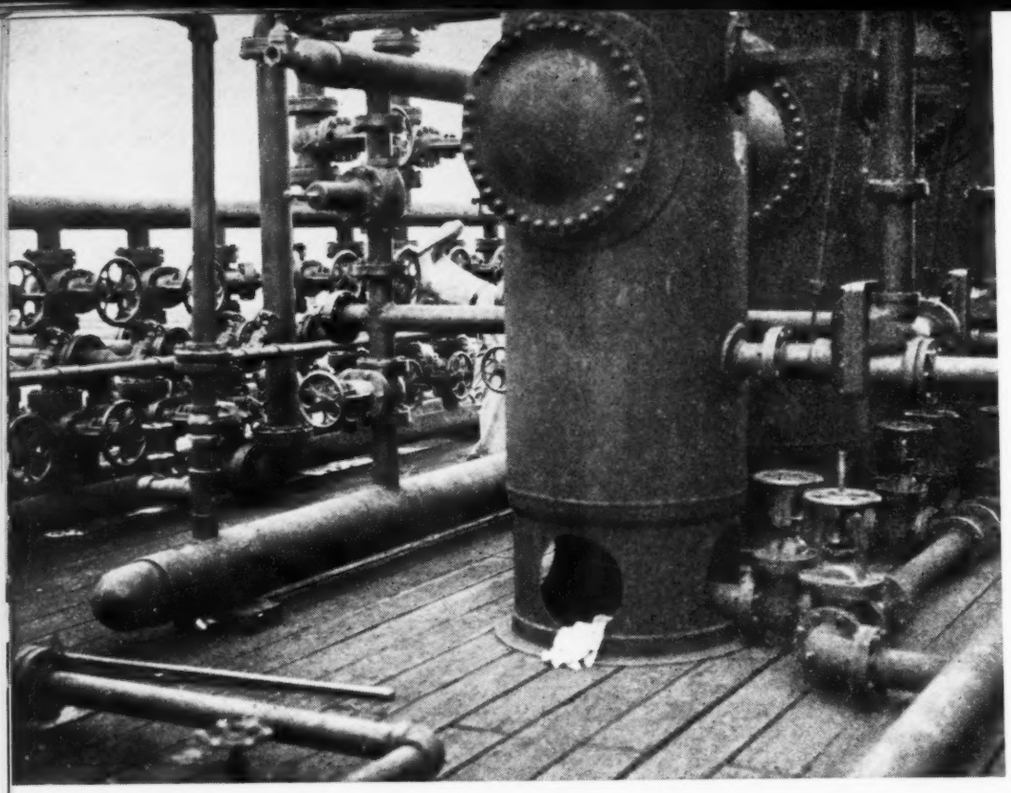


19. This is a typical flow station equipped with two 500-bbl. tanks for gauging and two 1000-bbl. tanks for storage. There usually are two separators but some typical stations have four. In the foreground can be seen the transformers. Note how compact and well arranged this gathering station is. All lines are laid on the Lake floor with incoming lines entering the separators, outgoing oil lines going to shore, and gas lines carrying gas to the nearest compressor station.

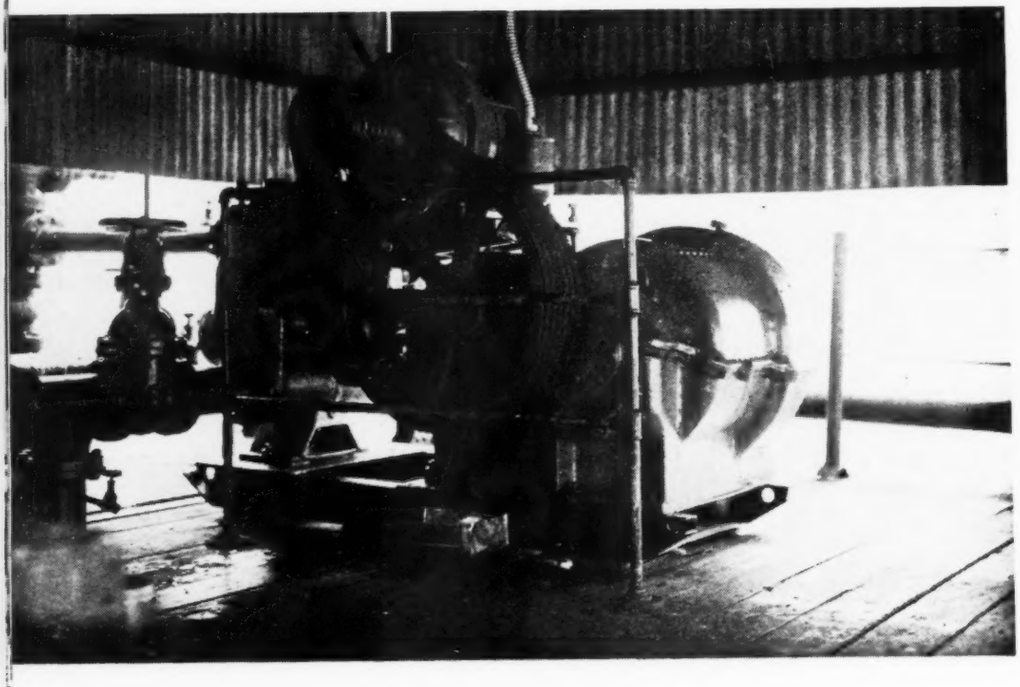


20. This flow station, together with a gasoline plant and compressor station, is situated at Lagunillas and is of different design from the usual type. It is connected by a walkway to the adjoining compressor station and gasoline plant.

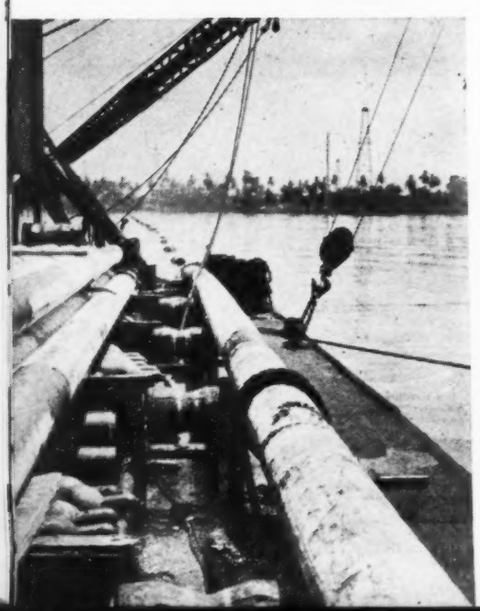


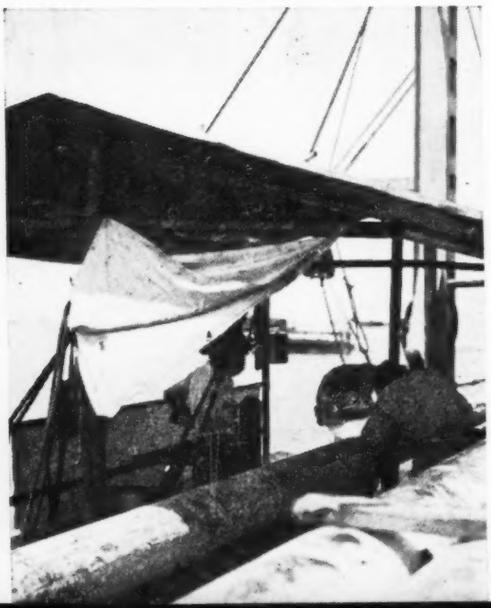


21. The manifold system at a flow station provides for flexibility in handling the wells. The oil from a well can be routed through any separator and from a separator into any tank. The small separator in the foreground is used for testing and by the manifold system provided, the flow of a well can be tested for volume of oil and gas produced at any time. Gas from the separators is piped direct to the nearest compressor station and the oil goes into the gauging tank. After gauging, the oil goes to a storage tank situated at the gathering station until it is pumped to the tank farm on land.



22. One of the two pumps at a flow station that pump the oil through an 8-in. line to shore. The pumps generally are 5½ by 10 reciprocating and are driven through a V-belt by 50-hp. motors with which they are mounted as a unit and bolted to the floor. Power usually is brought to the station transformer by submarine cables, although overhead lines from the power lines are used in some instances. The oil is pumped on schedule to prevent congestion of the lines, each of which takes oil to the tank farm from several stations. Some of the lines from gathering stations to shore are 10 in. in diameter and are floated in as shown in the photographs below.

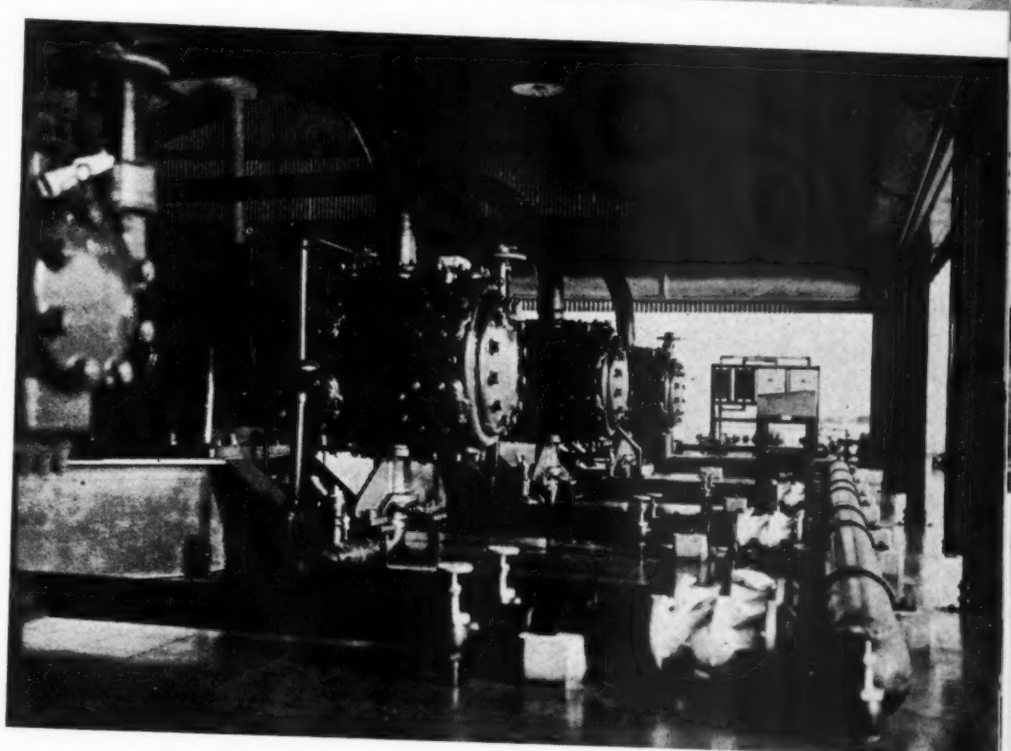




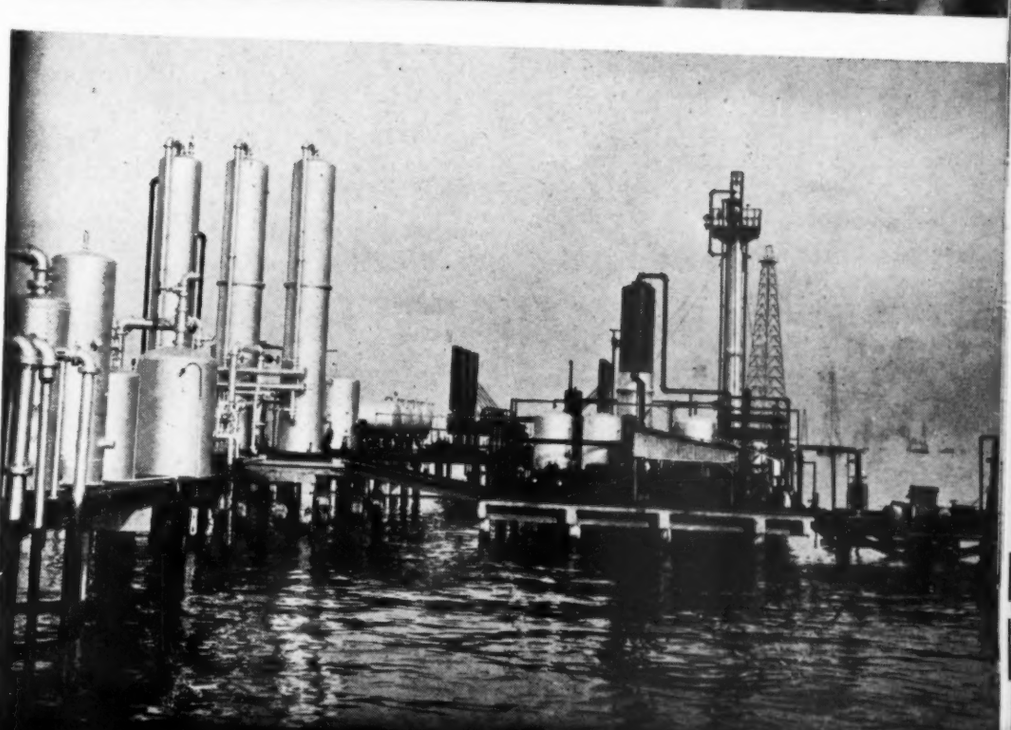
23. (Left) This 10-in. line is being floated to shore at Tia Juana by making up on the barge and shoving the line shoreward. This size line floats but barrels have been attached to mark its course.

24. (Right) The line is arc-welded on the barge. All lines laid in the water are coated with enamel before being placed on the barge. The welded joints after being made are treated with a coating material.

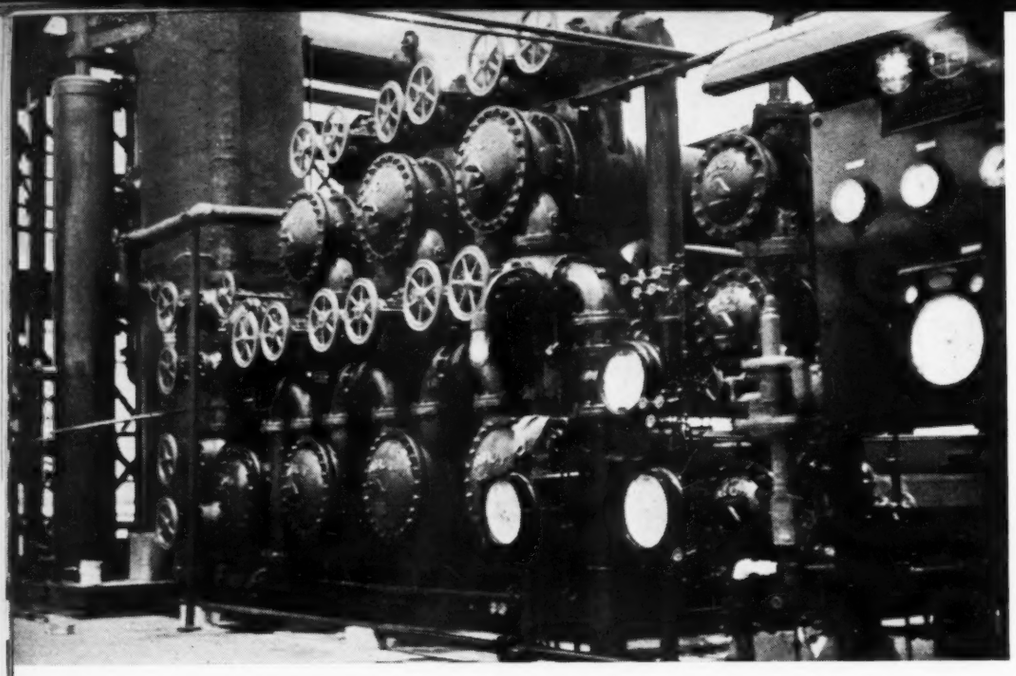
25. Gas from flow stations is piped to one of the compressor plants situated at convenient points out on the lake. From these plants the gas goes to an absorption plant, where the gasoline content is removed and the residue returned to the compressor plant for repressuring operations, or gas-lift. The handling of gas is shown in pictures (25) to (31). In (25) is shown a compressor plant at Lagunillas. The original plant can be seen on the right, a new addition on the left.



26. Here are three 19½-in. and one 11-in. cylinder compressors driven by 300-hp. electric motors in the new section of the Lagunillas plant. In other plants, compressors with cylinders up to 28 in. and motors up to 600 hp. are used, as described in the article in this issue on "Maracaibo Lake Fields Remain a Big Factor in Venezuela's Production." Compressors have been especially designed to reduce vibration to the minimum in the various plants built on the Lake. The plants themselves, however, are laid out to procure the same facilities as would be obtained in land construction and are permanent, well-designed structures. Note the reinforced concrete beams and floors (in the photograph above) built directly on the concrete piles with proper provisions made in the design to carry the engine load.

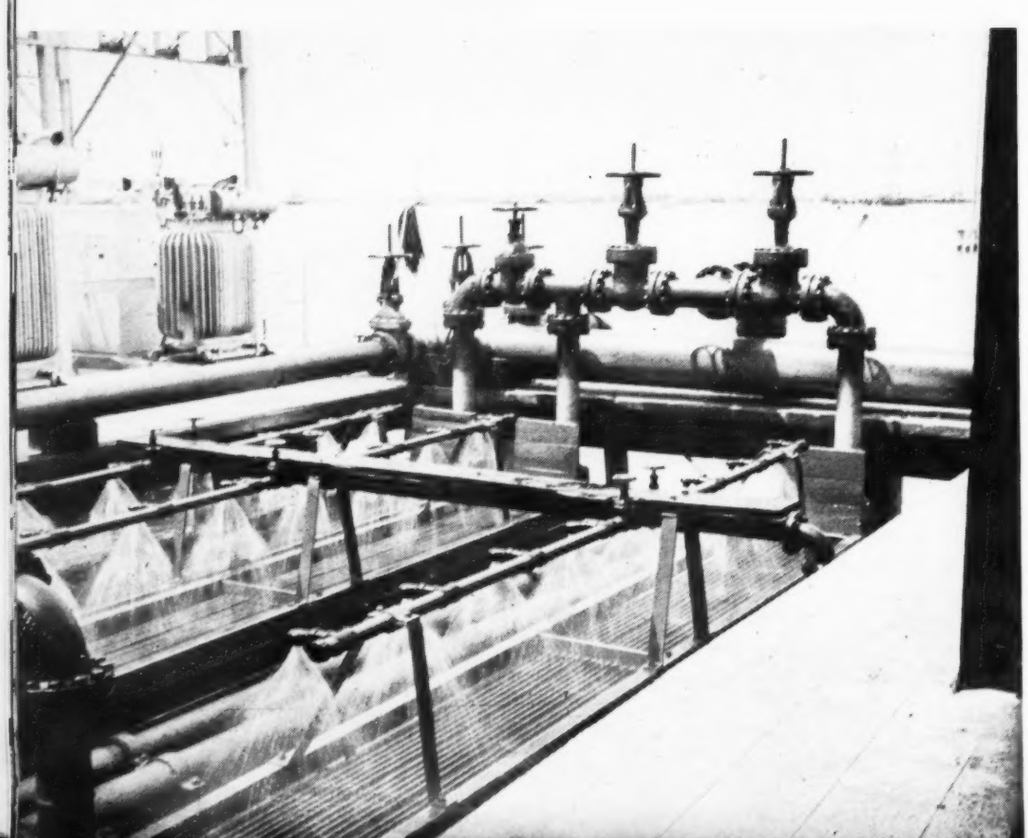


27. Absorption Plant No. 1 at Lagunillas. Situated on the lake, the arrangement of all units is most compact in order to require the least amount of substructure construction. Other plants are situated at convenient points in the northern fields of Lake Maracaibo and utilize similar equipment. The plant here shown has been built adjacent to the compressor station shown in photograph No. 25 but other plants are some distance away as can be seen in photograph No. 29.

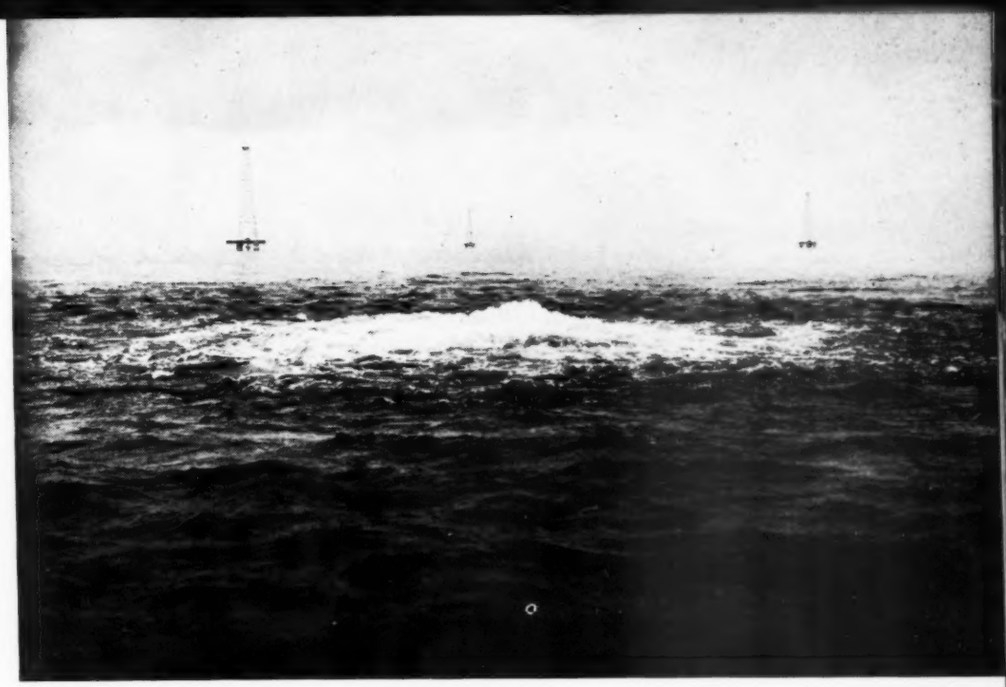


28. This unit is at La Rosa Absorption Plant No. 3. All space is utilized to the utmost but convenience and efficiency in operation are not sacrificed. Automatic control is employed to a great extent in all the plants and recording instruments provided at convenient points to aid in the operation, as indicated by the instrument panel on the right. Reinforced concrete beams and floors built directly on concrete piles provide permanent structures carefully designed to take care of the equipment used at the plants.

29. At La Rosa Plant No. 3 the absorption plant is some distance from the compressor station. After stripping, the residue gas is returned through a 14-in. line carried above the water, as a gas line larger in diameter than 8 in. will float. The 14-in. line is shown here with the absorption plant seen in the background. Gasoline made at the absorption plant is piped direct to shore through a submarine line which, being of small diameter, will not float. Also seen in the left background is the boiler station supplying steam for the absorption plant operation.

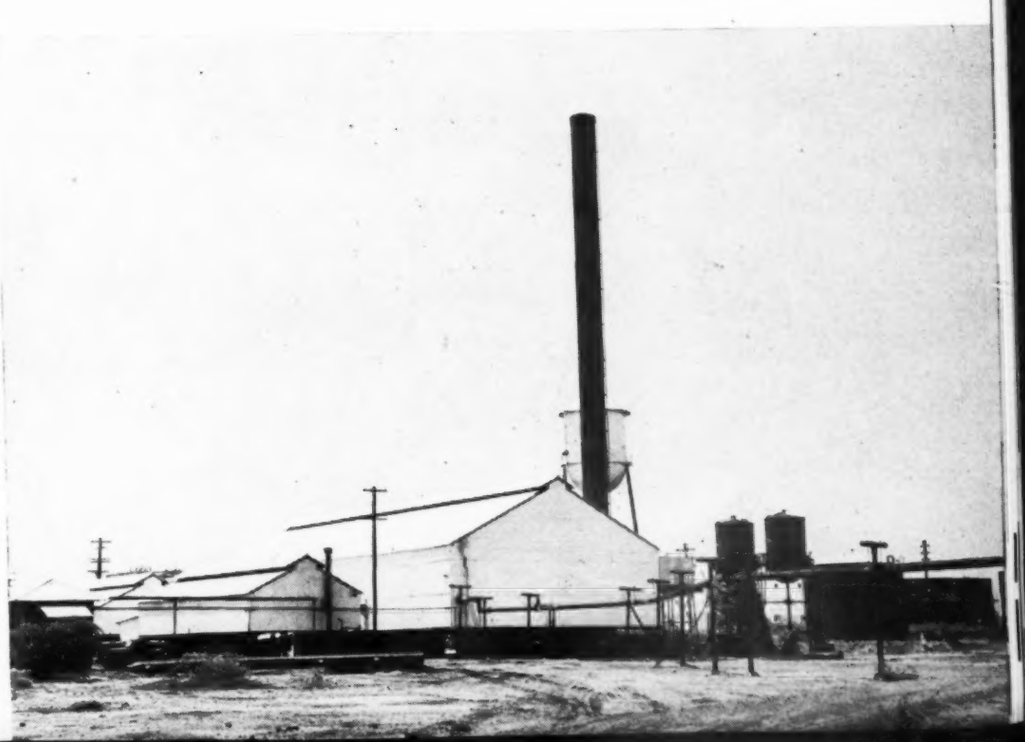


30. This cooling system, built at the end of a compressor plant, is used for cooling gas compressed to the intermediate stage of 250 lb. per sq. inch. The low-stage gas that is piped to the absorption plant is cooled by the Lake water enroute and the high-stage gas used for gas-lift or repressuring is cooled in the same manner on its way to the well. The intermediate gas, however, goes direct to the high-stage compressors and thus has to be cooled in the manner here shown. Lake water is merely circulated through the sprays for the purpose. At this station, the cooling system is alongside the transformers, which can be seen on the left.

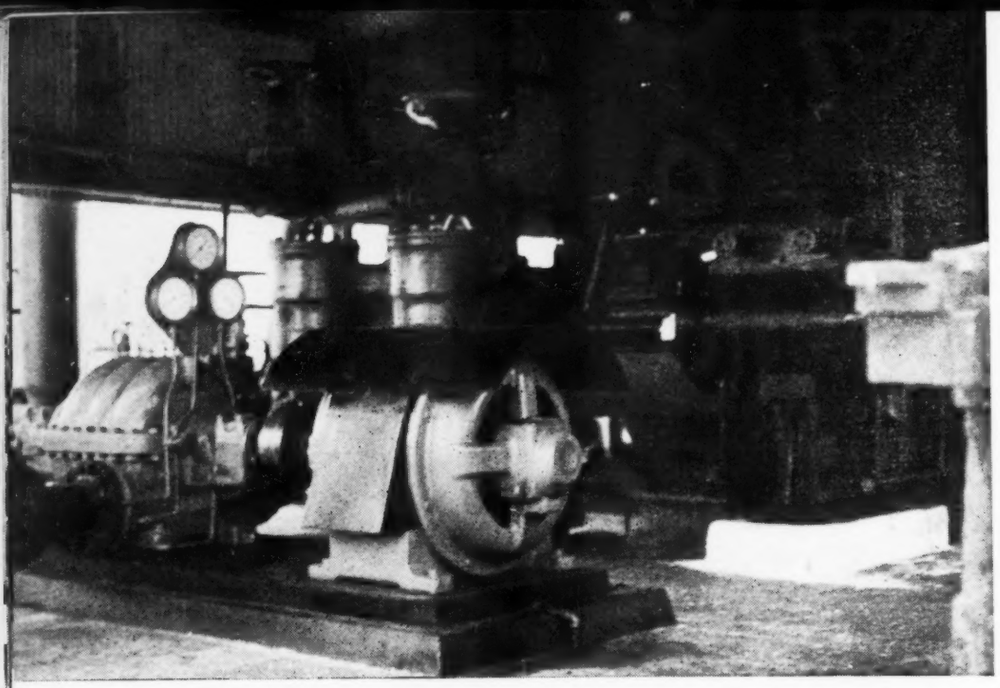


31. Exhaust gas readily is disposed of without danger on the Lake. Here it is shown bubbling up out of the water from the end of an exhaust line. No usable gas is wasted in the Lake operations and it readily can be seen how easily any leaks in a gas line can be discovered as the gas from such leaks would bubble up through the water and be immediately detected. With the complete equipment available for all kinds of water operations, leaks in both gas and oil lines are quickly repaired.

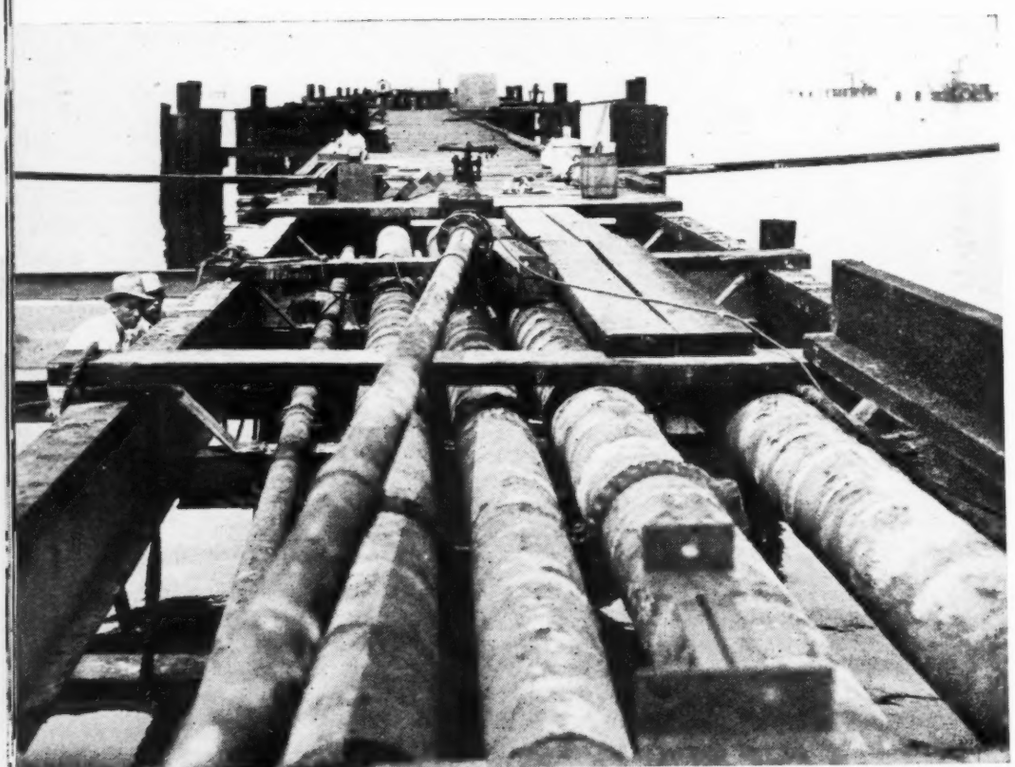
32. Some of the oil from the south end of the Lagunillas field has to be treated. For this purpose the Lago Petroleum Corporation uses electrical dehydration at one plant, shown here. Approximately 3000 bbl. of oil daily are passed through the plant. The oil averages about 12 percent cut and is cleaned to 0.6 percent. The location of the plant is just off shore and can be reached both from land and by water. While water is now showing up at the north end of the Lagunillas field, there seem to be no indications of encroachment in the northern fields of Ambrosio, La Rosa, Punta Benitez, and Tia Juana. No treatment of the oil has therefore been necessary at any of those fields.



33. Here is shown the central loading pump station at La Salina where oil is boosted from storage in the tank farm to the loading pier for shipment to Aruba. All oil produced by the Lake wells of the Lago goes via flow stations to tank farms situated on land at La Rosa, Punta Gorda, Ule (near Tia Juana), and Lagunillas. Equipment at the various stations has been increased from time to time to meet the changing conditions and different types of equipment are sometimes installed as shown in the next photograph.



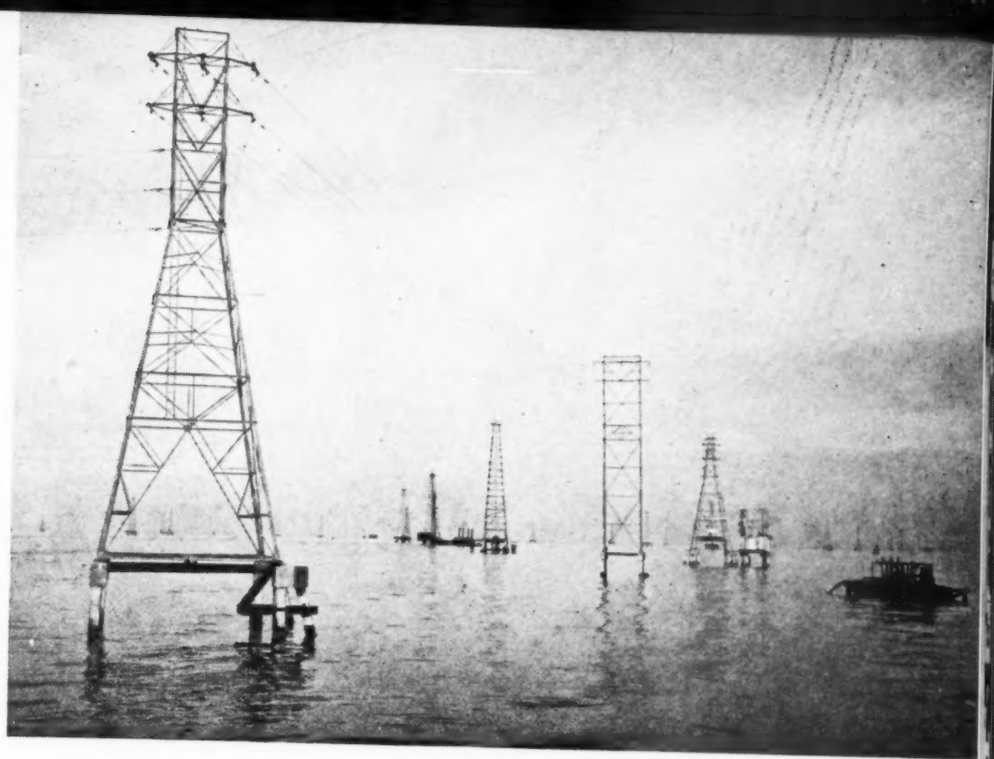
34. Inside the pump station at Lagunillas. This station was originally equipped with steam-driven reciprocating pumps, one of which can be seen behind the newer electrical unit. These steam pumps are still in operation but have been augmented by 6-in., 3-stage centrifugal pumps with a capacity of 700 gal. per min. each. The centrifugal pumps are electric-driven and are direct-connected to 100-hp. induction motors. In setting the new pump units they were placed between the older steam pumps without necessitating additional housing space.



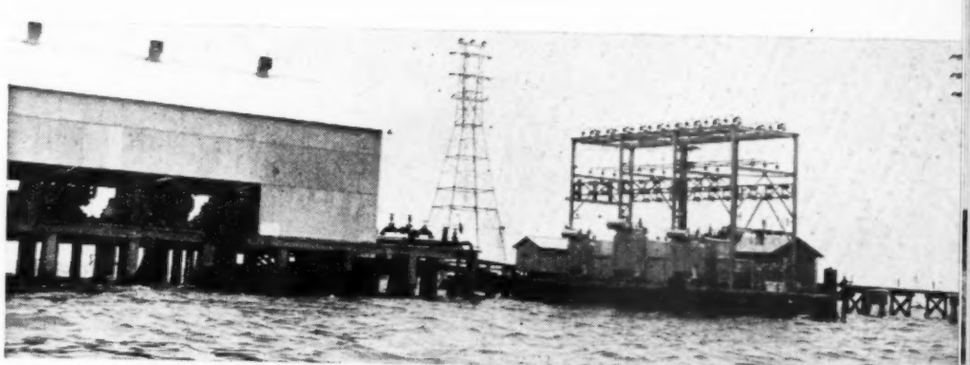
35. The loading pier at Lagunillas with the flooring removed to show the pipe lines servicing tankers. These lines consist of two 14-in. and two 10-in. oil lines, a 4-in. water line, and a 2½-in. air line. After loading, the oil line is blown out with compressed air to clean the line and keep oil out of the lake. Tankers taking on oil from the pier transport it to the refinery at Aruba. A similar pier, shown in photograph 36, is situated at La Salina. Freighters and ships of various sizes also load and unload at these piers, which provide for the shipments of tools, machinery, and materials used in the conduct of the Lake operations. The piers further provide for local transportation by speed boat, launches, etc., and for loading equipment on to boats for delivery to wells, stations, and plants on the Lake.

36. (Left) The pier at La Salina, looking from the outer end.

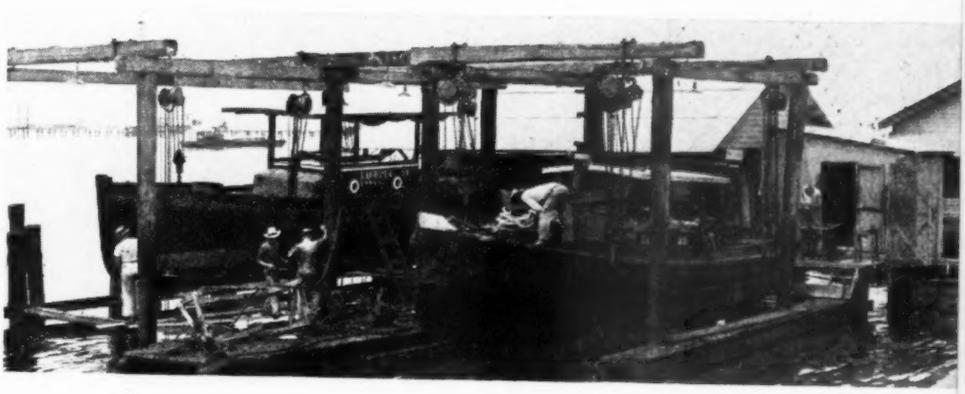
37. (Right) All operations of the Lago Petroleum Corporation except drilling are done electrically. Power for these operations is supplied by a power plant situated at Punta Gorda. The capacity of this plant is 15,000 kva.



38. The extensive use of electricity for operations on the Lake necessitates a complete transmission system over the wide water-covered area from Ambrosio on the north to Lagunillas on the south. Transmission lines are supported as shown here. The substructure is made with reinforced concrete piles cast for this specific purpose and the towers are built of structural steel. Note the line taking off from the tower at the left to serve as a branch line for operations in that direction. Between the two wide base towers can be seen a higher intermediate tower. These high supports are placed in the transmission line at certain locations to provide greater clearance.



39. Transformers at La Rosa compresser station. The voltage is stepped down to that needed at each point of operation. A flow station transformer station is shown in picture (19). Note the transmission line tower in the background of this illustration. Where lines are not so close, current is carried from them to the operation by submarine cables.



40. The launch repair shop at Lagunillas. The extensive amount of floating equipment, (barges, launches, etc.) naturally requires considerable maintenance facilities. At a larger dock at Cabimas, equipment can be built as well as repaired. Water transportation is a vital factor in the Lake operations and every boat and barge is kept in the best possible condition.

41. A fire barge at Lagunillas. This is hauled out to any Lake location and has been found effective in extinguishing fires. At other places along the Lake, fire boats sometimes are used.

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Venezuela...An Increasingly Important Factor in World Production

Approximately 23 percent of all oil produced in the world outside of the United States, and 70 percent of South America's total, is from Venezuelan fields, whose production is still on the increase

IT WAS not until 20 years ago that oil was produced in commercial quantities in Venezuela; and it was not until 1928 that the total annual production exceeded 100,000,000 barrels. This annual production has increased steadily, however, with a record high of more than 160,000,000 bbl. reached in 1936. This is more than nine percent of all the oil produced in the world during that year; it is about 23 percent of all the oil produced outside of the United States and 70 percent of South America's total production. Production still is increasing and the importance of Venezuela as a source of oil is obvious.

The future of Venezuela, however, rests not alone on the further development of present known reservoirs but also on the promising prospects indicated by exploratory work and by wells that, although not commercially productive under the conditions encountered, have given definite knowledge of the presence of oil in many localities throughout the western and eastern sections of the country. The existing fields capable of active production are shown on the accompanying map. The lake fields, of course, are of greatest immediate importance, with their present production nearly 70 percent of the total for the country, and their prospects for future development excellent. Quiriquire is next with nearly 15 percent, followed by Mene Grande with approximately ten percent. Details of operations in the various fields, together with a resume of wells drilled in various sections of the country, are given on the following pages.

Drilling and production methods followed are most modern; in fact, some developments in technique, now common generally, originally were introduced in Venezuela, for example electrical logging, which first was used to procure data on subsurface formations in a Venezuelan well. Gas wastage is practically nil and production practices are based on sound engineering principles. Production is controlled carefully to obtain the greatest volume of oil in the most efficient manner. Lifting power of the gas is utilized and conserved with a view to procuring the greatest ultimate yield from producing horizons.

Unhampered by multiple ownership of surface areas, drilling programs are carefully laid out and followed. This insures orderly development of fields and provides for minimum waste and efficient production of wells when they are completed.

Exploratory work, of course, is hampered by natural surface conditions in many parts of Venezuela. Jungle growth and swampy lands make geological and geophysical work both difficult and dangerous and present many obstacles in drilling wildcat wells. Many possible structures have been mapped, however, and many wells will be drilled. It is the extent of good oil indications already obtained, especially in Eastern Venezuela during recent explorations, that foretells a future that appears extremely bright at the present time. No one can predict the future definitely, but it seems safe to say that hopes for a greatly increased production in Venezuela in the not too distant future are at least justified.

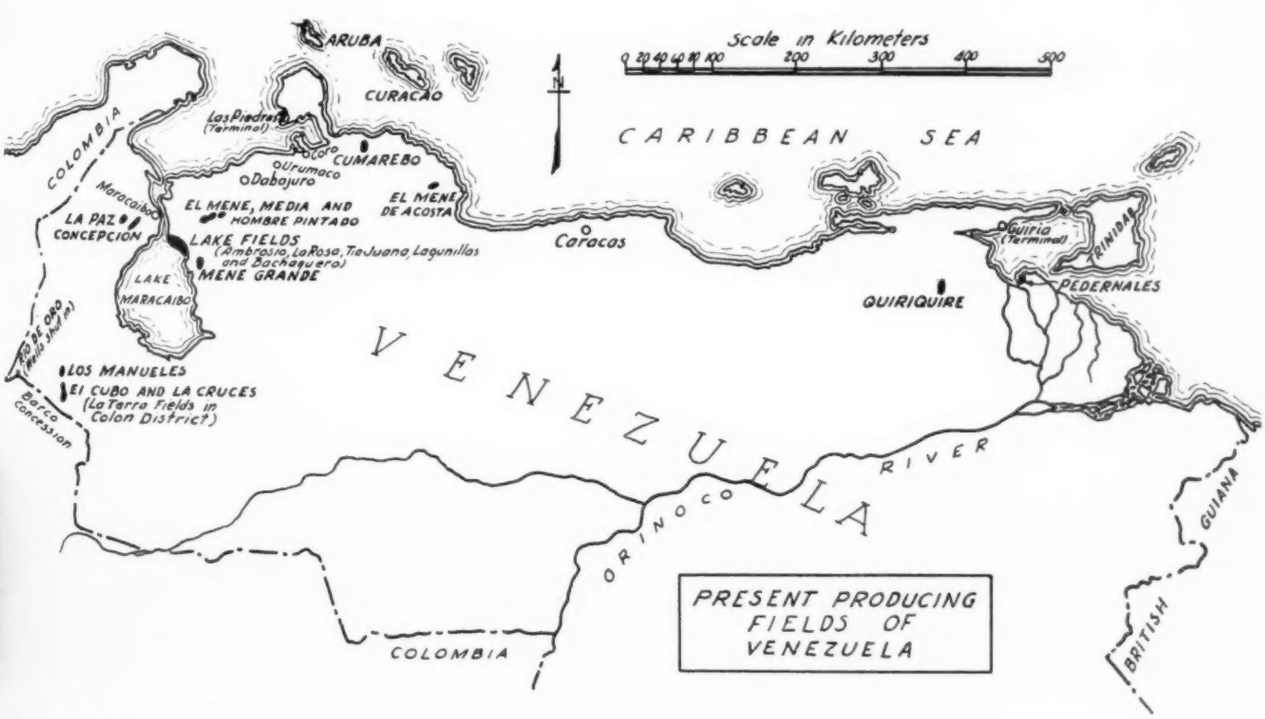

Fig. 1. Sketch showing oil fields of Venezuela

A consolidated compressor station, absorption plant, and flow station arrangement. Lago Petroleum Corporation's Plant No. 1 at Lagunillas

Maracaibo Lake Fields Remain a Big Factor in Venezuela's Production

Drilling and production methods are modern and all the latest engineering developments are adapted to operations on the Lake with great facility

WITH the future outlook for oil in Venezuela as a whole exceptionally bright and attention focused keenly on possibilities in other areas, the Lake Fields still seem to be the backbone of the country's prospects for some time to come. These fields have been producing for a long time and approximately one billion bbl. of oil have been recovered from the two general productive areas shown in Fig. 1. About 70 percent of Venezuela's production is, moreover, coming from these fields at the present time. Yet the entire proved areas of the present producing sands have not yet been completely drilled up; the Tia Juana field is now in the process of being developed, possibilities of its extension being toward the northern part of the Lagunillas field; Bachaquero, south of Lagunillas, is still not developed beyond a few tests, which indicate an area that can be developed at a later date.

The fields of the northern Lake area are not arbitrary divisions but are definite fields determined by structural conditions. The oil zones are faulted throughout the entire distance covered by the fields and are not found uniformly over the entire extent. The sands themselves are all very fine but very abrasive. Production at the present time is coming from above the Eocene and the relative positions of the various oil sands are shown in Fig. 2. The depth at which they are encountered increases consistently from north to south.

The sands being produced and their depths below the surface of the water, considering only the wells drilled in the Lake, are as follows:

Ambrosio Field: Producing from the Santa Barbara sand at from 1400 to 2700 feet.

La Rosa Field: Producing from the Lower Lagunillas, the La Rosa, and the Santa Barbara sands at depths ranging from 1600 to 2900 feet.

Punta Benitez Field: Producing from the Lower Lagunillas, the La Rosa, and the Santa Barbara sands at depths ranging from 1600 to 2900 feet.

Tia Juana Field: Will be developed mostly in the Lower Lagunillas, and some wells completed in the La Rosa sand. The probable depths will range from 2100 to 2700 feet.

Lagunillas Field: All present production from the Lower Lagunillas and Tar sands. The Tar sand is sometimes present, sometimes missing. Depths range from 3300 to 4800 feet.

Bachaquero Field: Development will be mostly in the Tar sand and the La Rosa. The Lower Lagunillas may be missing. Will probably call the producing zone the Bachaquero.

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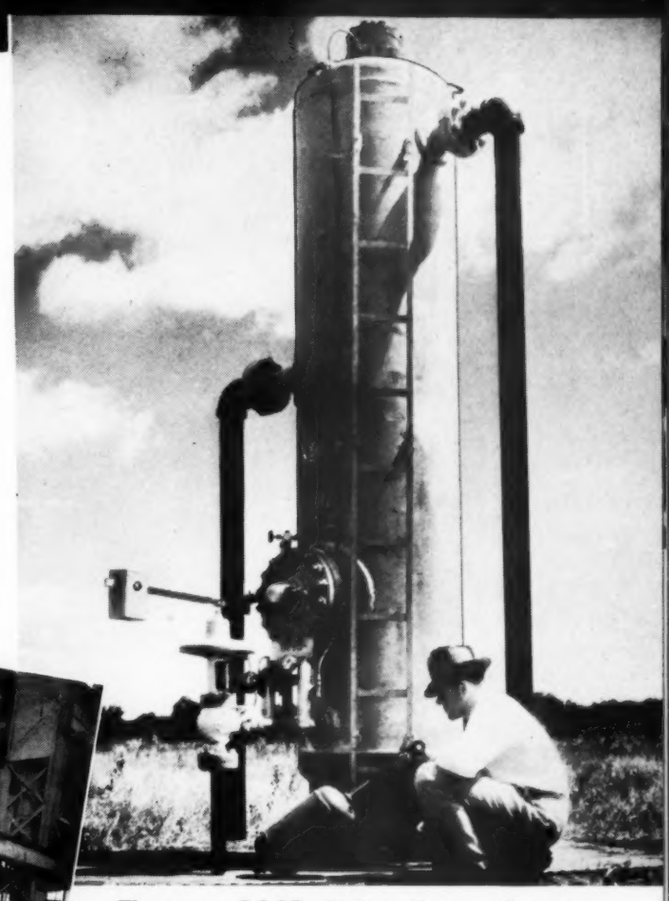

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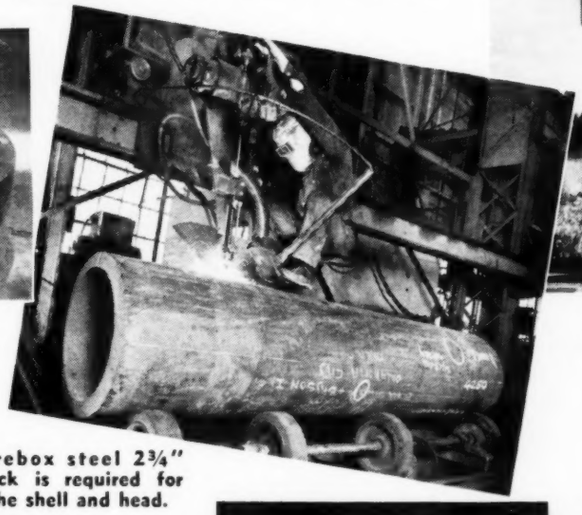
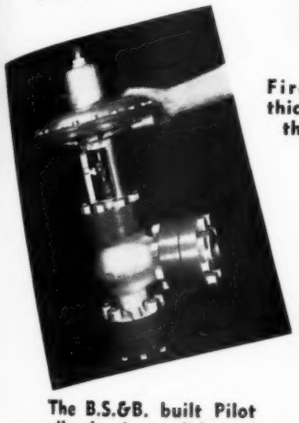


Firebox steel 2¾" thick is required for the shell and head.



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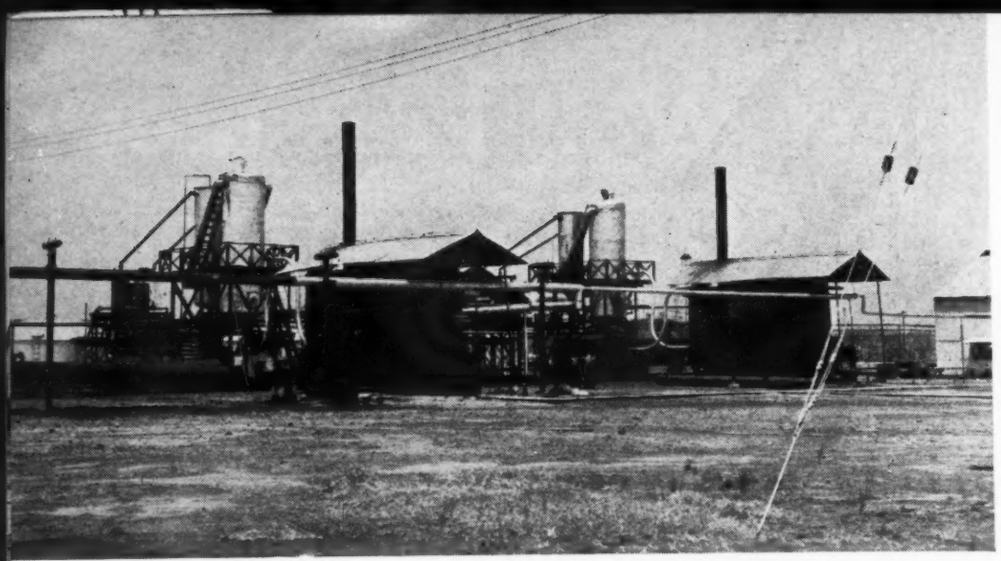


Lago Petroleum Corporation's topping plant at La Salina

The deepest well yet drilled on the Lake is Lago Petroleum Corporation Icotea No. 1, which reached a depth of 8750 ft. but was plugged back to 6740 ft. and temporarily completed as a gas well. This well is approximately ten kilometers off shore at Ambrosio, hence is almost in the middle of the Lake at that point (See Fig. 1.). This well penetrates the Eocene where the formations are found to be regular.

The well-spacing on the Lake is first at 1200 meters on an exploration line. After these locations are drilled as far off shore as desired, the next wells are drilled half-way between to make 600-meter spacing. The final filling in is between the latter wells to make the fully developed area covered with wells 300 meters apart. At the shore, of course, offsets are drilled to wells on adjoining property.

The Maracaibo Lake Fields are operated by three companies: the Venezuelan Oil Concessions, which is one of the Royal Dutch Shell group and has control of all land from the shore line inland; the Mene Grande Oil Company, which is a Gulf Oil Corporation subsidiary and operates strips just off shore; the Lago Petroleum Corporation, which controls all operations on the Lake except the strips held by the Mene Grande Oil Company. This division of property is shown for the northern end of the fields in Fig. 3. Except for the wider holding paralleling the shore at the extreme north end at Ambrosio, the Mene Grande Oil Company strips extend along the Lake throughout the distance of the fields. These strips are mainly one kilometer in width but are narrower or wider at some places. Those portions between the strips and the shore are operated by the Lago Petroleum Corporation as indicated on the map.

Necessary land facilities for the conduct of operations on the Lake by the Lago Petroleum Corporation and the Mene Grande Oil Company are provided along the shore. These are concentrated more or less at and around Cabimas (as shown in Fig. 3) and at Lagunillas at the present time, although expansion may be expected around Tia Juana when that field is more fully developed. The Mene Grande Oil Company and the Venezuelan Oil Concessions have their main plants and camps around Cabimas and Ambrosio for northern field operations. The Lago Petroleum Corporation operates from the strip of land shown at La Salina in Fig. 3. Tank farms are situated at advantageous points along the shore. The Lago storage is at La Rosa (La Salina), Punto Gorda, Ule (near Tia Juana), and Lagunillas. All three companies have similar camp, pier, and plant arrangements at Lagunillas. The oil from shore storage at Tia Juana is piped from shore and passes through risers to a loading rack by means of which it is loaded into tankers.

In general, crude shipments of Venezuelan Oil Concessions go by tanker from the company's piers at Cabimas and Lagunillas to the Shell refinery on

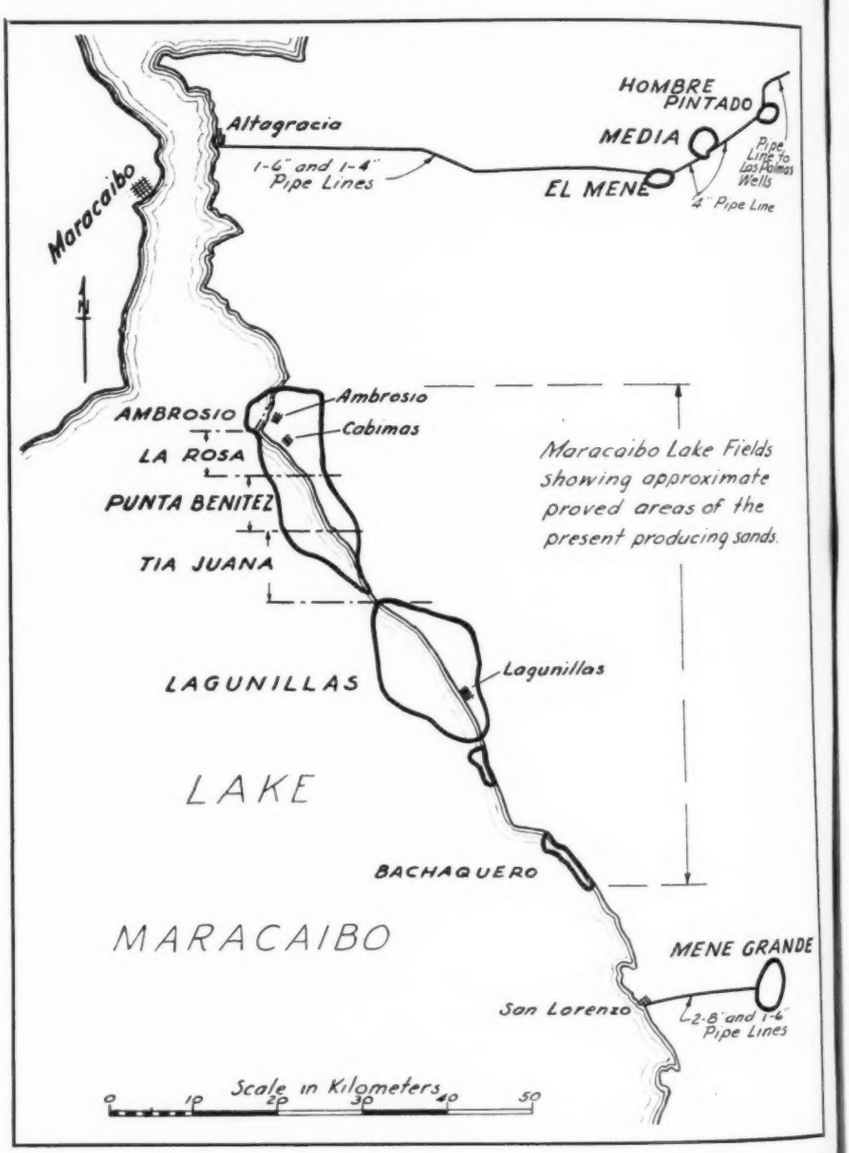
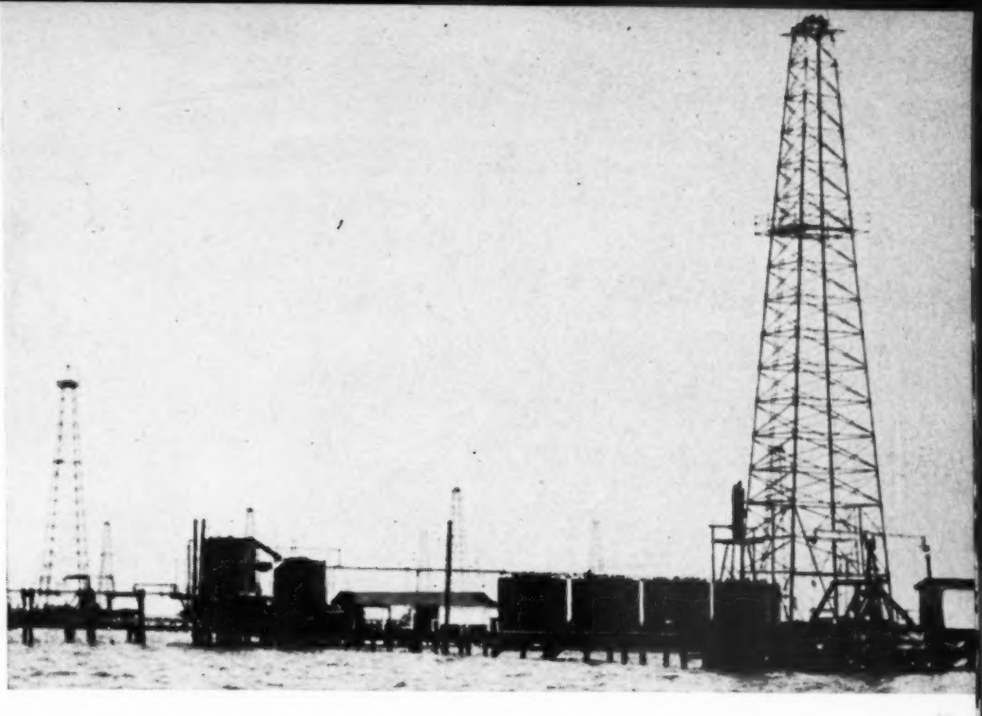


Fig. 1. Maracaibo Lake Fields



The Mene Grande Oil Company uses a system of chemical treatment. The wet oil passes through the elevated tank, which is filled with excelsior, and gravitates to the lower tank when the water settles out. From there it is pumped to storage

the Island of Curacao. Those of the Mene Grande Oil Company from its piers at Cabimas and Lagunillas go to Las Piedras on the peninsula of Paraguana, where the Gulf terminal is situated. From here it is loaded into big ships. The Lago Petroleum Corporation shipments from La Salina and Lagunillas piers go to the Standard refinery at Aruba.

All companies have built excellent camps for the Venezuelan employees. Transportation is also provided and a new highway between Cabimas and Lagunillas has aided greatly in the transportation problem, not only for operations on land but for those on the Lake.

Off-Shore Procedures

In their operations beyond the shore line of Lake Maracaibo, the Lago Petroleum Corporation and the Mene Grande Oil Company follow two different methods. The former, having wells out almost five miles from shore make each location, flow station, compressor station, and absorption plant a distinct island, although in some cases a flow station, compressor station, and absorption plant may be consolidated as in the case of Plant No. 1 at Lagunillas. All connections with the shore and transportation between units are by boat except, of course, the carrying of oil, gas, and gasoline, which is done by pipe lines. Pipe lines of the Lago, however, are laid on the bed of the lake but those of the Mene Grande generally are supported above water and beneath cat walks to wells, flow stations, and plants.

Operations of the Mene Grande Oil Company extend only about one kilometer from shore, so walk-ways supported by piles connect many of the units with each other and with the shore. The use of boats, however, is extensive and the personnel is transported most advantageously by launches. The walk-ways are about five ft. above water and small boats of the dory type powered by gasoline engines are used for purposes requiring passage under the walks. The handling of material is done by boat, and the character of material and service governs the size of floating equipment necessary for transport. Flat-decked steel barges, many of which are equipped with derricks, are used for handling heavy pieces of equipment.

Among the barges employed by the Mene Grande Oil Company are those used in driving the piles for foundations; for transporting material for, and the building of, rigs and other structures; for cementing operations;

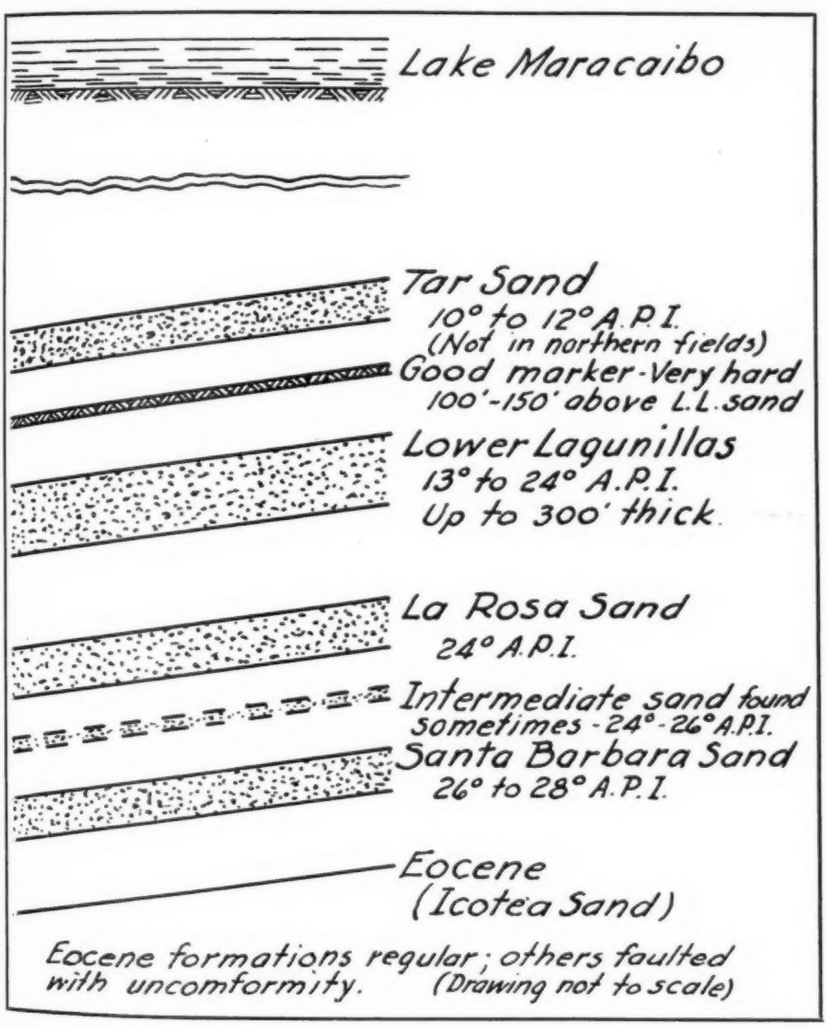
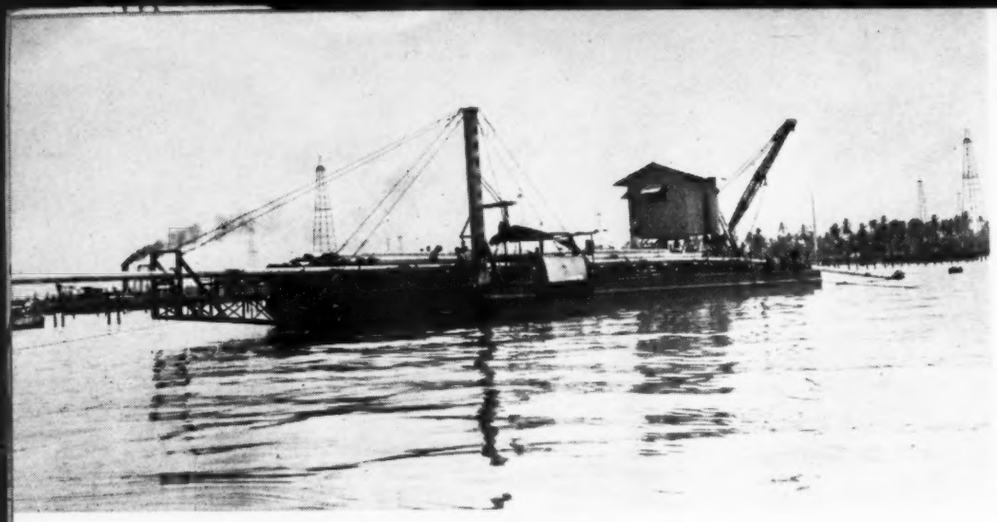


Fig. 2. The sands now being produced below the water of Lake Maracaibo are shown here in their relative locations stratigraphically. The sketch is diagrammatic and does not portray relative thickness or distances between strata



Pipe line barge laying a 10-in. line from shore at Tia Juana

for cleanout work, and for recovering piles. The pile-pulling barge is equipped with a specially-designed lifting hoist and is used continuously in recovering piles that have served their purpose. The various types of barges are towed and maneuvered by tugs but maintain and change their position by means of anchors. Some of the latest barges are self-propelled and driven by Diesel engines.

Steam for drilling by the Mene Grande Oil Company is supplied by batteries of boilers erected on pile foundations. Each of these batteries is so situated as to be able to service a number of wells; it is connected by a catwalk to each well as it is being drilled. At each well the pipe rack, mud ditch, and other facilities are also provided on a pile-supported structure. A cementing barge is brought up to the well for cement jobs, the barge taking the place of the cementing truck as employed on land operations. A drilling well and boiler plant are illustrated in accompanying photographs, which can be compared with the illustration of a drilling well of Lago Petroleum Corporation where all equipment except that on the derrick floor and engine room is portable and floating.

The Lake operations of the Lago Petroleum Corporation, extending for a distance of nearly five miles from shore in water that ranges from a few ft. to more than sixty ft. in depth, have necessitated the development of drilling and production methods that will meet not only present conditions but also any future requirements that may arise in the complete development of an extensive productive area entirely covered by water. Walk-ways between wells, flow stations, and plants, and to the shore obviously are impractical. Pile-driving is a necessity but by erecting on piles only structures that are permanent and by carefully designing the foundations and structures to meet the conditions at each location, the amount of piling has been reduced and all temporary use of piling avoided.

Structures erected by Lago on the Lake, therefore, consist of derrick locations serving for drilling and production, flow stations, compressor stations, absorption plants, power-line supports, and such auxiliary buildings as manifold houses. Derrick locations include, in addition to derrick floor equipment, only cantilever extensions for the engine used during drilling and a pumping unit when such is necessary for production. All other equipment such as mud pumps, mud ditches, vibrating screens, drill pipe, casing, boilers, etc., are carried on barges that are transported to the well for service.

All other facilities for the conduct of operations are also handled by portable, floating equipment. Launches and speed boats carry men and small parts. Derrick barges handle heavy equipment while lighter barges are used to transport smaller tools and machinery. Some of the barges are self-propelled and others are towed by tugs.

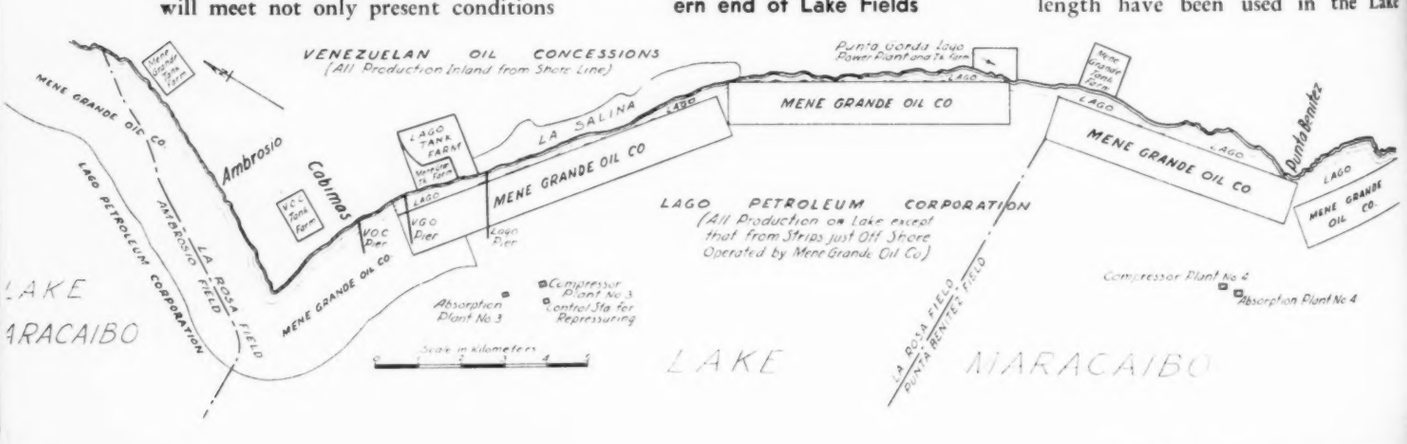
Lake Operations

In developing the procedure being followed in drilling and producing wells on Lake Maracaibo, the Lago Petroleum Corporation has evolved an efficiently coördinated operation that is completely planned from the time the location is made. A pictorial record showing the sequence of operations is given under the title of "Lake Maracaibo Operations . . . As Told by Camera," and appears on pages 52 to 63. More complete details covering the Lago operations follow herewith.

The foundation work on all the structures erected on the lake has been given careful study and the use of reinforced concrete piles to support all such structures is now universal practice. With the depth of water and character of the structure widely different and with concrete piles not easily cut off to any length desired after being driven, the length and cross-sectional area of the piles for each structure must necessarily be determined in advance. A test pile is therefore driven at each location, whether it be for a well, a flow station, or for any other purpose. From this test pile data are obtained regarding the length of pile necessary to give the desired penetration for the size and number of piles to be used in the structure to be erected. The size of pile is governed by penetration.

With complete data thus obtained, the reinforced concrete piles are precast by the company in a plant at La Salina. They are made up in three cross-sectional sizes. Piles 16 in. square are used for lengths up to 69 ft.; those 20 in. square for lengths of 70 to 100 ft.; and piles 24 in. square for lengths over 100 feet. Precast piles of extreme length have been used in the Lake

Fig. 3. Off-shore operations at northern end of Lake Fields



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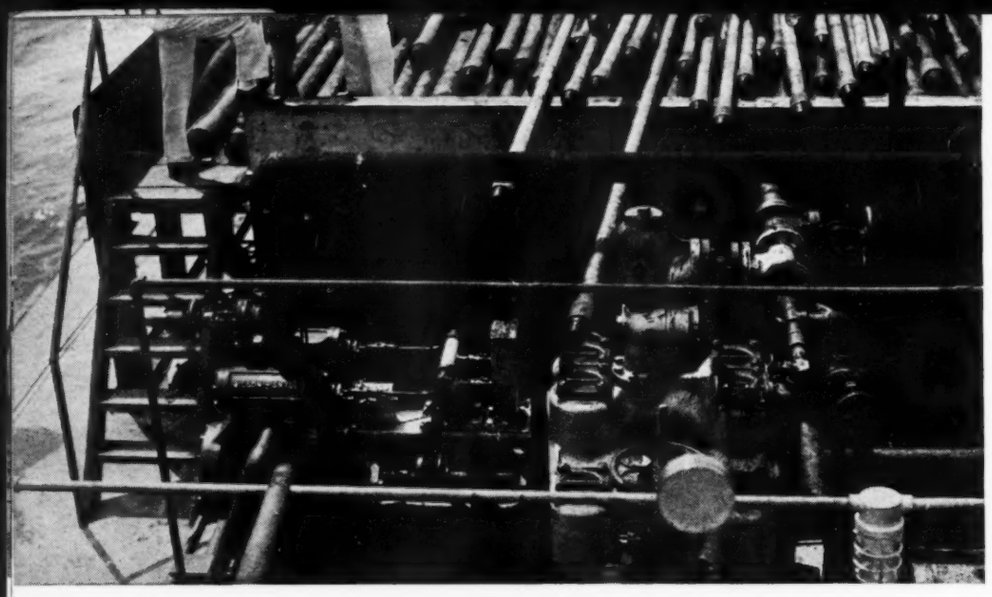


Left: Mud pump on a drilling barge

Below: The Lago Petroleum Corporation's mud plant at Lagunillas

operations with the longest used for well foundations, being 133 ft. in length by 24 in. square.

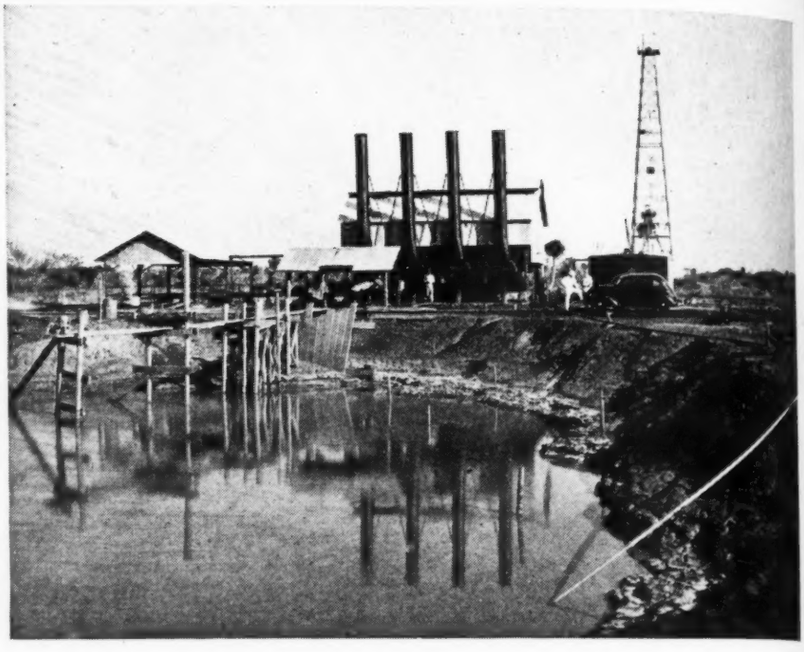
The pile driver used for driving the concrete piles is exceptionally flexible in operation. It can swing 90 deg. on the driver and can drive batter piles front, back, or either side. It is rated at 50 tons on a 30-deg. angle, has a 110-ft. beam, and has to be moved only once in driving an entire derrick location. After coming up to the test pile it first puts down a batter pile off the side. A plumb pile is then driven to complete the corner after which it swings in front to drive in sequence one plumb, one batter, and one plumb pile. The barge then moves back to drive two plumb piles and from there into the other corner to drive two plumb and one batter piles. Then it swings to the third corner to drive the last batter pile off the side.

The pile-driver barge is equipped with four 5000-lb. anchors and two 1000-lb. anchors, the latter being used to square up. Movement of the barge is from an anchor line handled by a steam hoist. Piles are picked up from a barge on which they are carried to the location with a 3-point pickup by a derrick on the pile-driver barge set in the lead. Steam for operations is generated by three boilers, one of which is a spare. Fuel oil is hauled out on a fuel barge and stored on a tank that holds a two weeks' supply.

After the piles for the derrick structure have been driven they are stripped to elevation and then capped with reinforced concrete. When the concrete caps have set, a steel base is set upon them and grouted in. The derrick is then erected and after completion the drilling barge is moved in and the well rigged-up. The rigging-up is usually done in half a day.

Flow stations are built with steel I-beam stringers resting on the reinforced caps that top the piles in the same way as on the derrick foundations. These stringers run lengthwise under the tanks and on them is laid a wooden floor. The pump house at a flow station, however, is constructed with concrete floors and concrete stringers placed on the piles.

Compressor stations and absorption plants necessarily are designed for the equipment to be installed but the size and length of the piles for their foundations are determined in the same manner as for other structures. Reinforced concrete beams and floors are built directly on the piles with proper provisions made in the design for foundations for engines and other heavy pieces of equipment.



Drilling Methods and Equipment

In addition to the regular rotary rig with drawworks, table, crown and traveling blocks, hooks, and all other equipment on the derrick floor and in the derrick, a steam engine is placed on the concrete-pile supported structure built at a location. The sizes of twin steam engines now in use are 10 by 10 and 12 by 12 but there is a possibility that larger ones will be employed later. All other equipment and facilities are provided on the drilling barge, which is towed to a drilling location and anchored with four anchors, one from each corner.

The barge is built with two decks forward from the boilers and pumps, both of which are set in the stern. Steam is piped to the rig with a hose connection between the derrick and the barge and is supplied by three 250-lb. boilers. The mud fluid is circulated by a 6¾ by 14 and a 14 by 7¼ by 18 or two 14 by 7¼ by 18 pumps. A mud-settling ditch is provided below the upper deck of the barge and mud returns, carried through a flexible hose from the well, are passed through a vibrating screen before going into the ditch when such screening is necessary.

In compartments (of which almost the entire lower deck is composed) are stored mud fluid for replenishing the mud supply and fuel oil for firing the boilers. Above these the upper deck extends the full width of the barge and from the front to the position of the mud pumps and boilers, which are set on the rear end of the lower deck. The front end of the drilling barge is kept parallel to the side of the drilling rig and with a ramp connecting the

upper deck with the derrick floor, facilities for handling drill pipe and casing are provided similar to the pipe rack used in land operations. There are 12 drilling barges in active use in all the Lake fields and these are adequate to handle the drilling program, which depends on the construction of piers.

During drilling, each well is equipped with a cellar control gate above which is a blow-out preventer. The only cellar is the space between the derrick floor and the water but remote control wheels to the control gate and blow-out preventer are provided at the sides of the floor. Formation pressures now encountered are not high and rarely go above 1500 lb. per sq. inch. Three shallow gas sands in the northern fields are drilled with mud weighing 81 lb. per cu. ft., this usually being sufficient, but in some instances mud as heavy as 94 lb. per cu. ft. is used; all mud is held at a funnel viscosity of about thirty. Very little weight material is added to the mud although at Punta Benitez some weight material is used on every well.

Mud is transported to drilling operations by means of a mud barge equipped with two 250-bbl. tanks. The fluid is pumped from the tanks into the storage compartments on the drilling barge and is there made available for replenishing the circulating stream as needed. Returns from the well, run to a sump near the pumps after passing down the settling ditch, and conditioning of the mud fluid is made with additions from storage as needed. Spent mud usually is discharged into the Lake. When oil or any other ingredients in the spent mud are likely to contaminate the lake water, however, the old mud is transported back to land on the mud barge and there disposed of.

At Lagunillas a mud plant is operated to supply a good drilling fluid for lake operations. The arrangement of the plant is shown in Fig. 4 and a view looking across one of the mud pits is given in an accompanying photograph. The mud is mixed at the plant and pumped by four 6¾-in. mud hogs that are set below ground in a concrete pit. The plant is about a kilometer from the lake shore and the mud fluid is pumped from there to two storage pits situated on the Lake. From here it is loaded on to the mud barges through a pipe line carried on a short pier.

Electrical logging is used in all wells and equipment for making the log is transported to the well on a self-propelled motor barge. The apparatus is built in a compact unit and mounted on skids. When it reaches the barge it is hoisted up and set in position on the upper deck where it is prepared for operation as soon as the well is ready to be surveyed.

Two general casing programs are being followed at the present time. One is used in the northern fields and the other in Lagunillas field. An exception to this is that future wells in the Tia Juana area, which is now being developed, will be completed similarly to the wells in Lagunillas. Typical representations of the two programs are given graphically in Figs. 5 and 6.

At La Rosa and Punta Benitez, wells are spudded in with an 18-in. or 22-in. bit and this size hole carried to a depth of from 40 to 150 feet. A conductor string is there set and cemented from bottom to the lake bed. A 15-in. hole is then drilled to a depth of 700 or 800 ft. and a string of 11¾-in. casing run and cemented. The hole is continued with a 10¾-in. bit to just above the top of the Lower Lagunillas sand where an 8⅝-in. water string is set. This string is cemented up to the 11¾-in. string and provides a complete shut-off of water from any source whatever above.

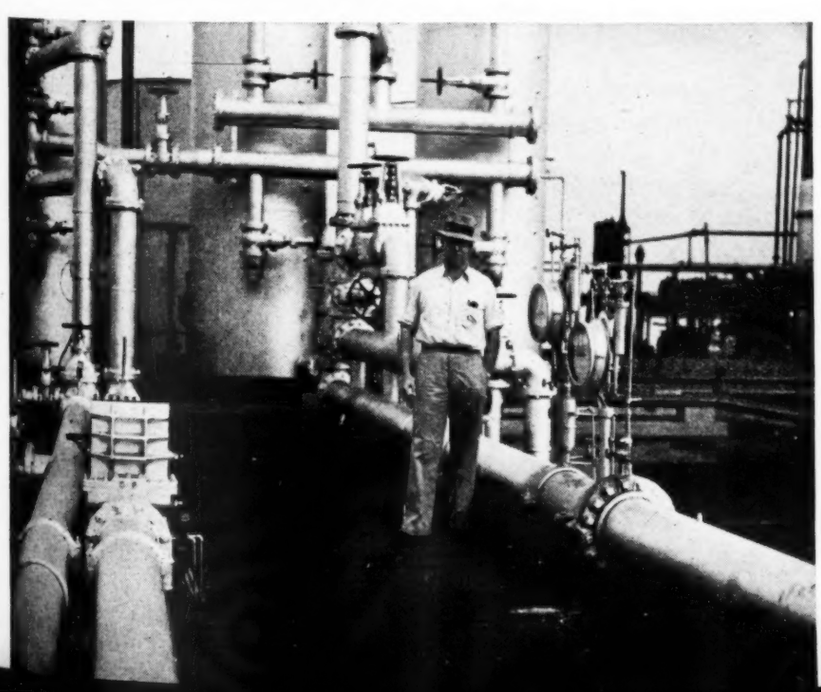
Derrick barge for handling heavy equipment

As already pointed out, production in the La Rosa and Punta Benitez fields comes from the Lower Lagunillas, La Rosa, and Santa Barbara sands. A 7¾-in. hole is therefore drilled through the horizon to be produced and a 6⅝-in. liner run with perforations opposite this horizon. The liner is of the combination type and is cemented through the casing point, the cement being carried in all cases up to the 8⅝-in. water string in which it is hung. As shown in Fig. 5, which depicts a well completed in the lowest sand, all sands above the one being produced are cemented off.

A good, very hard marker is picked up at from 100 to 150 ft. above the Lower Lagunillas sand. In drilling through the lower zone, however, the hole is frequently carried to Eocene to obtain a check on the log.

The casing program for the Lagunillas field and also for future wells at Tia Juana is quite different from the foregoing. Two joints of 16-in. pipe are welded to a 11¾-in. surface string, which usually is set at about 250 feet. The 11¾-in. pipe is cemented from bottom to top and cement is deposited in the annular space between the two 16-in. joints and the 11¾-in. pipe as shown in Fig. 6. It is felt that additional protection against action of the lake water is obtained for the one

(Continued on page 78)



Meters and orifice fitting, Lago's Absorption Plant No. 1, Lagunillas

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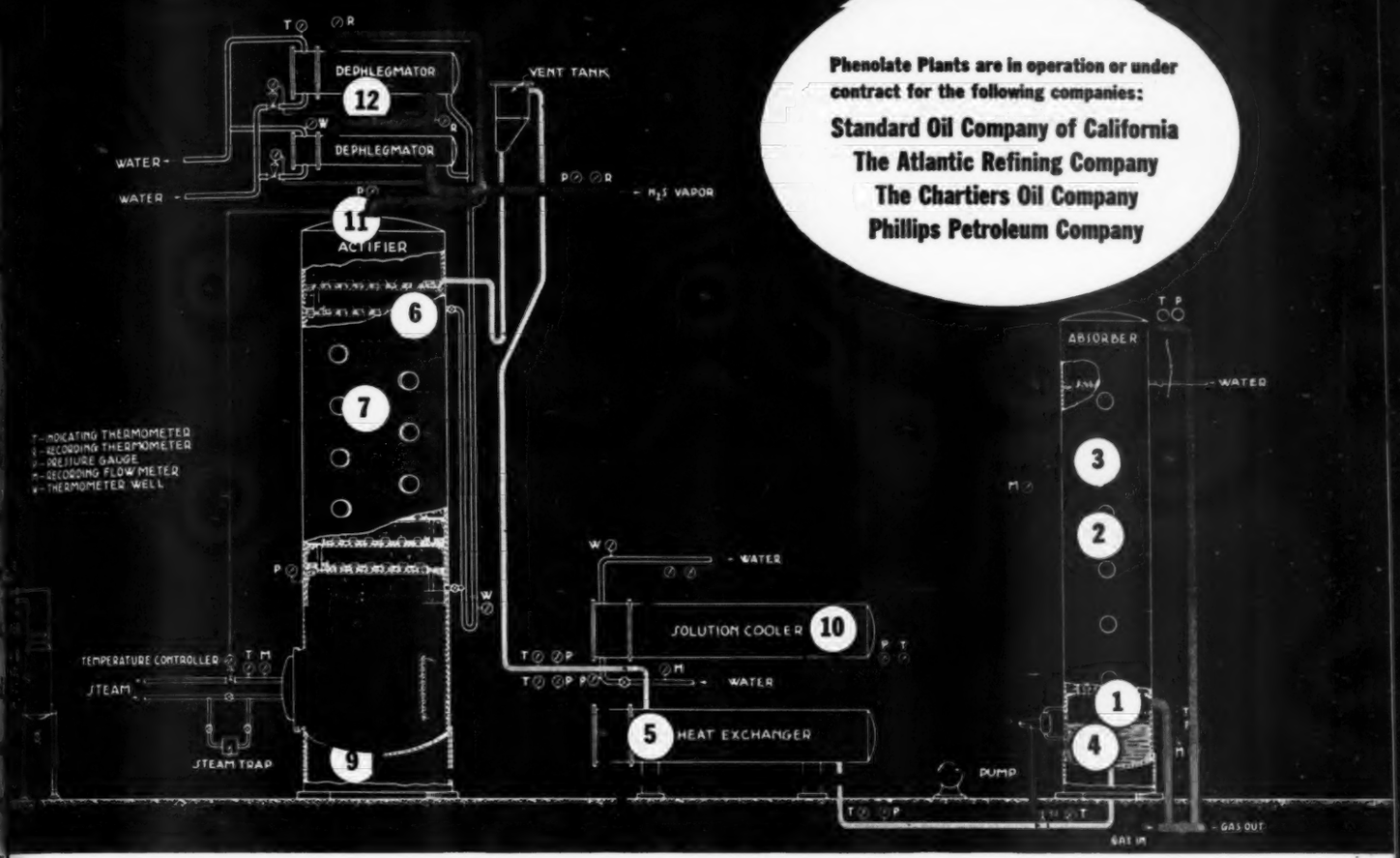
Phenolate Process



Phenolate Plants are in operation or under contract for the following companies:

Standard Oil Company of California
The Atlantic Refining Company
The Chartiers Oil Company
Phillips Petroleum Company

ABSORPTION PHASE

The hydrogen-sulfide laden gas enters the absorber at (1), passes up through the bubble-cap trays (2) and leaves at the top. Through absorption by the phenolate solution which entered at (3), the gas is stripped of 95%—99.8% of its hydrogen sulfide.

ACTIFICATION PHASE

The sulfided phenolate solution collects in the bottom of the absorber, passes out at (4) into the heat exchanger (5) and into the top of the Actifier at (6). It flows down over the actifier trays (7) through stripping-steam, generated in the reboiler (8), which removes the hydrogen sulfide from the phenolate. The phenolate then flows from the reboiler at (9) to the heat exchanger (5), is further cooled in the solution cooler (10), and is introduced again into the absorber, ready for another absorption phase.

RECOVERY PHASE

Steam, laden with hydrogen sulfide, leaves the top of the actifier at (11) and passes into the Dephlegmators (12). The condensed steam is returned to the actifying column, and the recovered hydrogen sulfide is forced, by actifier pressure, to the acid plant burner, or other point of utilization.

The three top trays of the absorber are filled with water, and act as strippers to recover entrained or evaporated process chemicals. Fresh water is fed to these trays continuously. At periods of several days, chemicals lost from the system must be replenished. A small mixing tank is provided for this purpose.

Koppers Phenolate Process is covered by U. S. Patents Nos. 1,971,798; 2,002,357; 2,028,124; and 2,028,125.

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DESIGNERS . . . BUILDERS . . . PRODUCERS . . . MANUFACTURERS . . . DISTRIBUTORS . . . OPERATORS

Camp provided by Lago Petroleum Corporation at Lagunillas for Venezuelan employees

(Continued from page 75)

string of casing in which a combination of 6⅝-in. string is run.

Production in the Lagunillas field is from the Lower Lagunillas and Tar sands and in the Tia Juana field it will be mostly from the Lower Lagunillas, with some production from the La Rosa. The combination string is therefore perforated opposite the horizon to be produced and the pipe cemented through the casing point, the cement being carried on up behind the pipe to protect any upper sands. In Fig. 6 the well is shown completed in the Lower Lagunillas with the Tar sand cemented off.

Producing Lake Wells

The general procedure on completing wells is to wash them until the oil shows. The fluid is then run into a barge in order to prevent contamination of the Lake. Wells usually come in as soon as the face of the sand is clean but sometimes they have to be assisted with air-lift. The air for this purpose is provided by a barge on which are set two compressors driven by 100-hp. gasoline engines. The sand is very fine and very abrasive and tends to get into the liner. A back-pressure is held on all flowing wells and greatly reduces trouble from sand in addition to contributing to more efficient production operations. Wells are producing usually through 2½-in. tubing with five joints of 2-in. on the bottom of the string.

All flowing wells produce through beans, the back-pressure being regulated to meet individual well conditions. The gas/oil ratio at Ambrosio is approximately 1800 cu. ft. per bbl.; at La Rosa 1200; at Punta Benitez 1000; and at Lagunillas 600 cu. ft. per barrel. At Tia Juana the gas/oil ratio has not been fully determined but it is expected to be kept as low as 200 or 300 cu. ft. per barrel.

The aim in producing the Lake fields quite evidently is great efficiency that will prolong the life of the fields and lead to the greatest possible ultimate economic yield. Subsurface studies are being carried on continuously and each well is being made to produce with the most effective volume, pressure, and gas/oil ratio possible. Pressure measurements on tubing and casing are recorded and samples of oil for B.S. and gravity are taken daily. Oil gauges and measurements of gas volume also are taken every day.

At the present time there are almost 2200 wells producing in all areas in the Lake fields with a total daily production by all companies of approximately 375,000 bbl. of oil. Of these wells, about one-half are producing by natural flow, one-quarter by gas-lift, and one-quarter by pumping. Wells on the Lake are pumped with individual units and those on land with both individual pumping units and central pumping powers. Pumping wells in general are equipped with standard make pumps but some plunger-lift installations are in operation.

Oil from wells on the Lake goes to flow stations built at convenient locations for handling the production from a number of wells. The typical flow station has two 500-bbl. tanks for gauging and two 1000-bbl. tanks for storage. Some stations have greater capacity. Separators at the various stations handle the various wells flowing into the station. At the typical station there usually are two separators but some have four. At larger stations the battery of separators contains several units. All stations have a manifold system for diverting the flow of wells into the different tanks and for measuring individual well production of

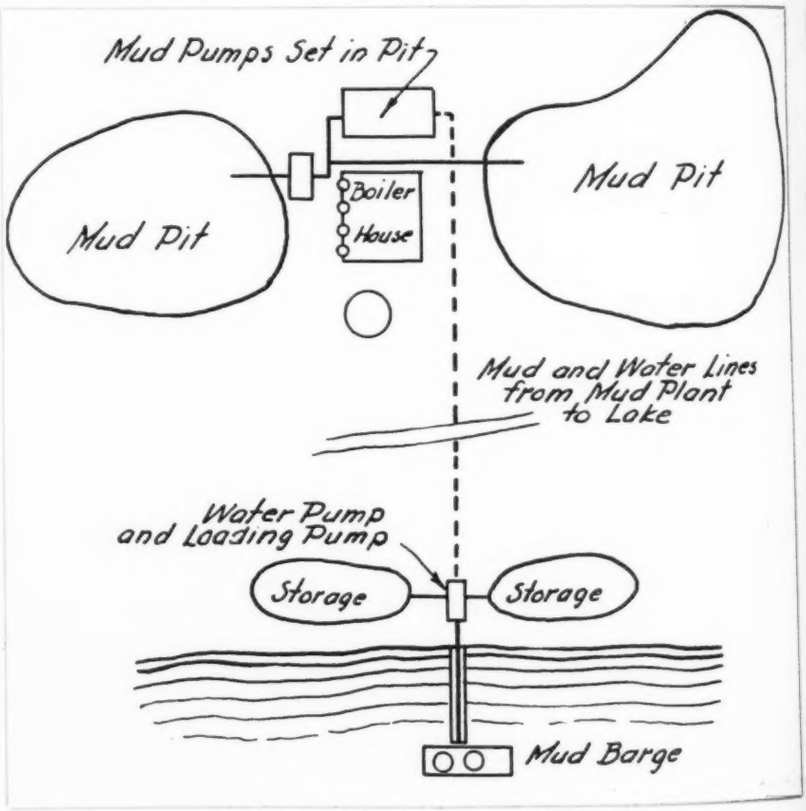
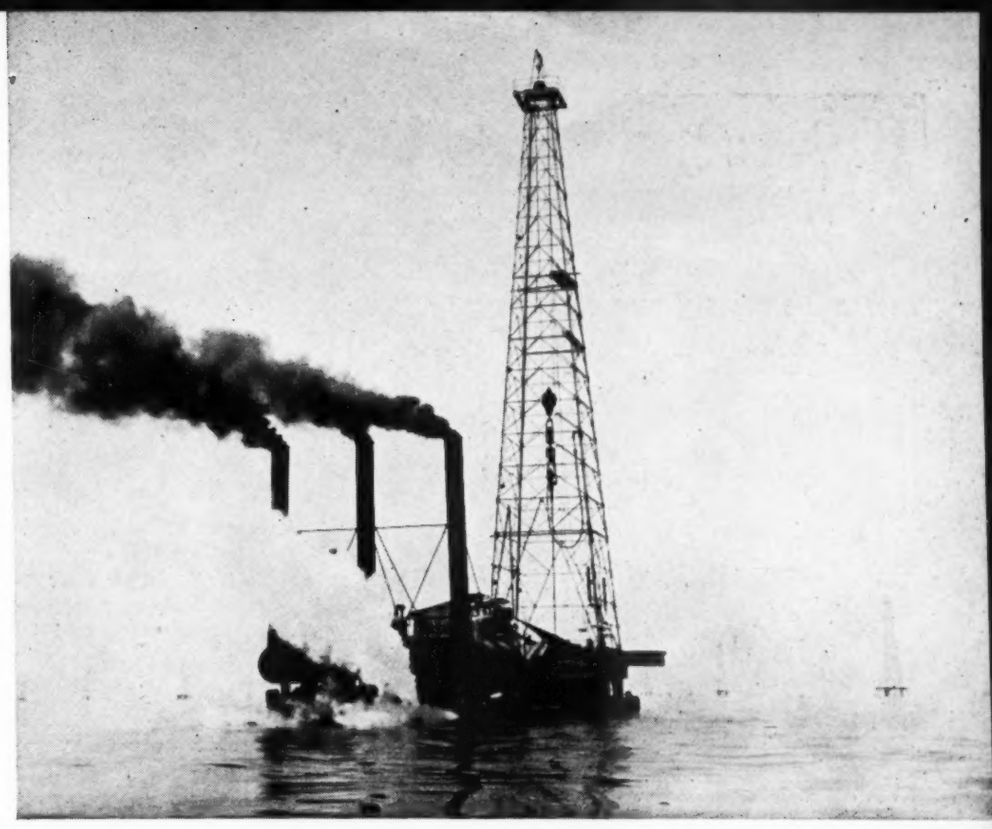


Fig. 4. Sketch showing arrangement of Lago Petroleum Corporation's mud plant at Lagunillas



Lago drilling well, Punta Benitez field

both gas and oil at any time. Frequently, small separators are installed for test purposes.

Oil is pumped from the flow stations to tank farms on shore through 8-in. lines, each of which picks up oil from several stations. The stations dispatch oil on a regular schedule so that pressure on the line can be kept down by not having too many stations pumping at once. The length of time that the oil remains in storage at a station depends on the production of the wells flowing into the station.

The pumping is done by electrically-driven reciprocating pumps of which there are two at a typical station. These usually are 5½ by 10 pumps driven by 50-hp. motors through V-belts. The pump and motor are mounted as a unit on skids and the unit bolted to the floor.

Although water has begun to encroach from the north in the Lagunillas field, only oil from the south end of that field is now being treated. Electrical dehydration is used by Lago Petroleum Corporation and two units handle 3000 bbl. of oil per day. The oil has a gravity of 18 deg. A.P.I. with a viscosity of from 1200 to 2000 SSU at 100 deg. fahr. and is cutting an average of about 12 percent. After treatment it is 0.6 percent. The units are somewhat overloaded and more equipment will be installed to take care of this oil and that from the north end of Lagunillas, which has a gravity of about 15 deg. A.P.I. and a viscosity of from 3000 to 4000 SSU.

The Mene Grande Oil Company treating plant, also on the Lake at Lagunillas, uses chemical treatment. The cut oil here passes through an elevated tank filled with excelsior. From this tank it gravitates into a lower tank where the water settles out. The oil is then pumped to storage on the land.

Utilization of Gas

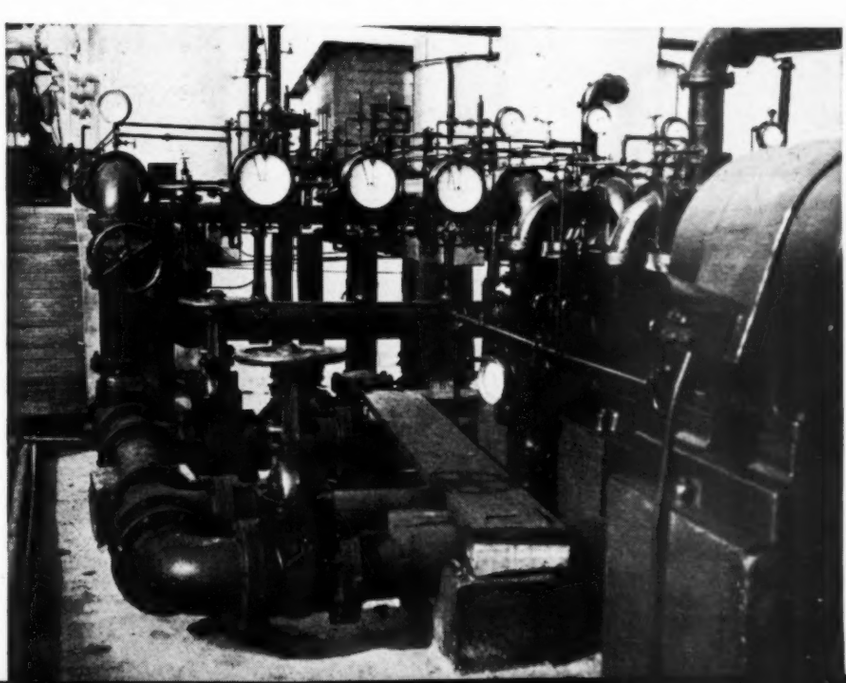
All the gas produced in the Lake fields is utilized. That not utilized for fuel or other operations is used for gas-lift or repressuring. Repressuring of the Lake wells is confined to the northern fields only at the present time while most gas-lift work is in Lagunillas. With the development of the Tia Juana field it is expected that some of the wells there will be put on gas-lift as the necessity arises.

Gas from flow stations passes through an 8-in. line to the nearest compressor station where it is compressed to the pressure necessary for treatment in an absorption plant located nearby. After stripping, part of the residue is taken off as fuel and the remainder returned to the compressor station. At the compressor station the necessary pressure for gas-lift or repressuring operations is built up and this compressed gas then piped to the wells.

In some instances where the pressure is satisfactory, the gas from the flow station goes direct to the absorption plant. In a few instances a high-pressure separator is placed at a flowing well and the gas that is taken off goes direct to the gas-lift system. This gas is produced at high pressure and is taken from the separator at about 450-lb. pressure. The oil from the separator goes to a flow station where the rest of the gas is recovered. All the gas from wells producing on the Lake is treated except that taken directly from the high-pressure separator. Some gas from the Lagunillas field has a gasoline content as low as 0.5 gal. per thousand cu. ft. and the average for all fields is probably less than 1.0 gal. per thousand.

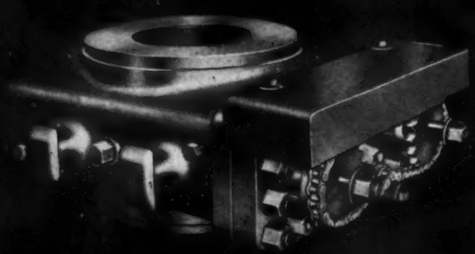
The operation of compressor stations and absorption plants varies with the conditions in each field. The general procedure employed on the Lake can be indicated by Compressor Station No. 3 and Absorption Plant No. 3, which handle the gas produced from and also that for repressuring the La Rosa field. The location of these plants is shown in Fig. 3 to be about three kilometers off shore at La Salina.

(Continued on page 82)

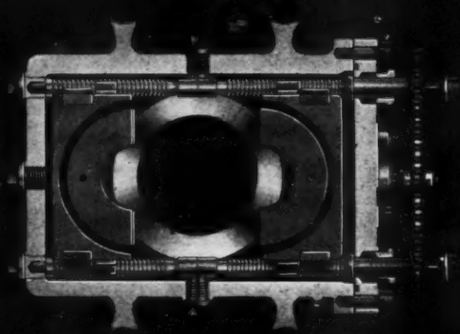


Flow controller for absorption oil plant No. 1, Lago Petroleum Corporation, Lagunillas

AND HOW **SHAFFER** PROVIDES



Shaffer "Screw-type" Cellar Control Gates are tested to 6,000 lbs. per square inch; also made in "flange-type".



Looking down through the gate shown above. Rams are made to fit any size pipe that will pass through the bore of the gate; also for complete shut-off.

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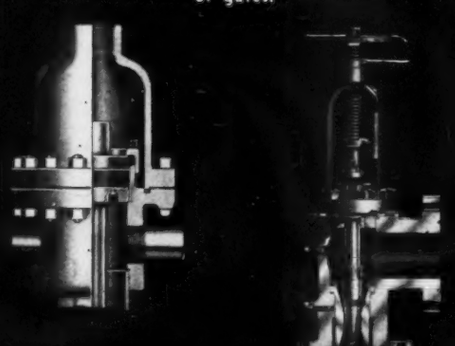


Warren Control Heads for packing-off around Kelly or drill pipe.

Shaffer Adjustable Flow Beans provide smooth flow and accurate control.

You can depend upon Shaffer "Safety-First" Control Equipment to control your well under all drilling conditions and methods.

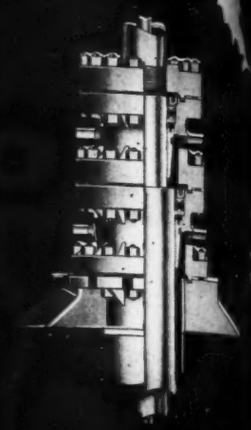
When drilling with weighted mud fluid, a Shaffer Cellar Control Gate and Warren Control Head adequately safeguard the well when high pressure gas pockets are encountered.

When drilling under pressure, the Shaffer Rotating Blow-out Preventer packs around the Kelly, and with the Shaffer Adjustable Flow Beans on the overflow line, the pressure is regulated as required.

The Shaffer Rotating Blow-out Preventer Body and its bonnet are designed to release the Rotating Packing Assembly with a left hand one-eighth turn of the bonnet. By closing the pipe rams in the upper gate, the drill pipe is stripped through the gate rams and the rotating assembly removed with the Kelly. The stripper assembly is then inserted in the Body and locked in place by a right hand one-eighth turn of the bonnet, and upon opening the gate rams the pipe is removed from the well. Every detail has been provided for safe and efficient removal and running in of the drilling string.

There is no interference with drilling operations—only a minimum of vertical space in the cellar is required—drilling hook-ups can easily be replaced by production hook-ups—and above all, complete control is provided from the time drilling commences until the well is put on production.

It will pay you well to study the Shaffer Section, which starts on page 1548 of the 1937 Composite Catalog or write for the Shaffer Catalog, free to any oil man requesting it.



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While drilling-in and tubing th... well, the Shaffer Universal Tub... Control Head insures comp... safety.

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If your well should blow in through the drill pipe, a Shaffer Kelly Cock will safely control it.

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Operators in fields far from the source of supply, appreciate the unfailing operation of SHAFFER FISHING TOOLS, PACKERS, and other tools. Each product has been developed to meet a specific need, and is constructed to require few repairs or replacements for safe, efficient operation and long life.

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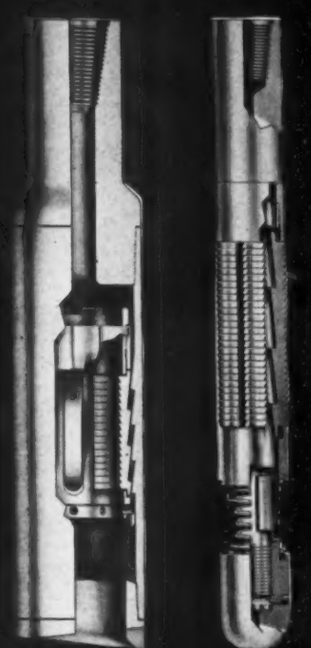
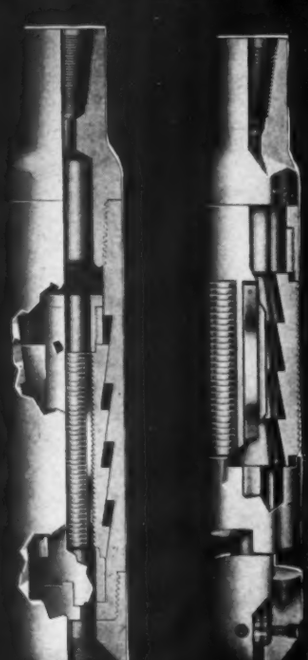


Shaffer T. & T. Rotary Releasing Sockets and Spears are unexcelled for left hand work.



Shaffer-Hamon Rotary Releasing Sockets and Spears are world famous for right hand tools.

YOU WILL FIND THE SHAFFER SECTION on Pages 1548 to 1577 of Your 1937 COMPOSITE CATALOG

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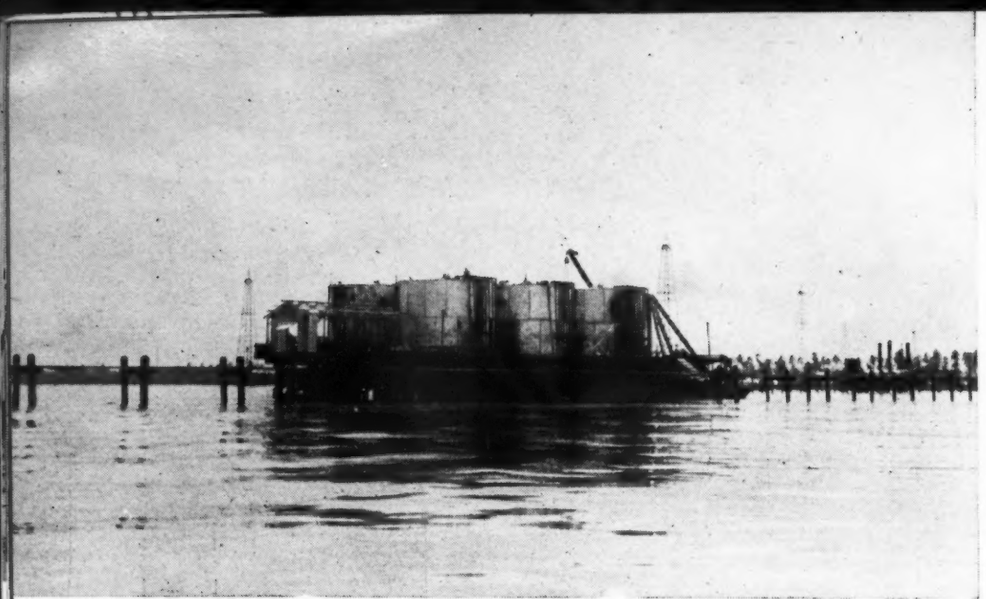


A Mene Grande flow station showing pipe line running to shore on pile-supported walk-way

(Continued from page 79)

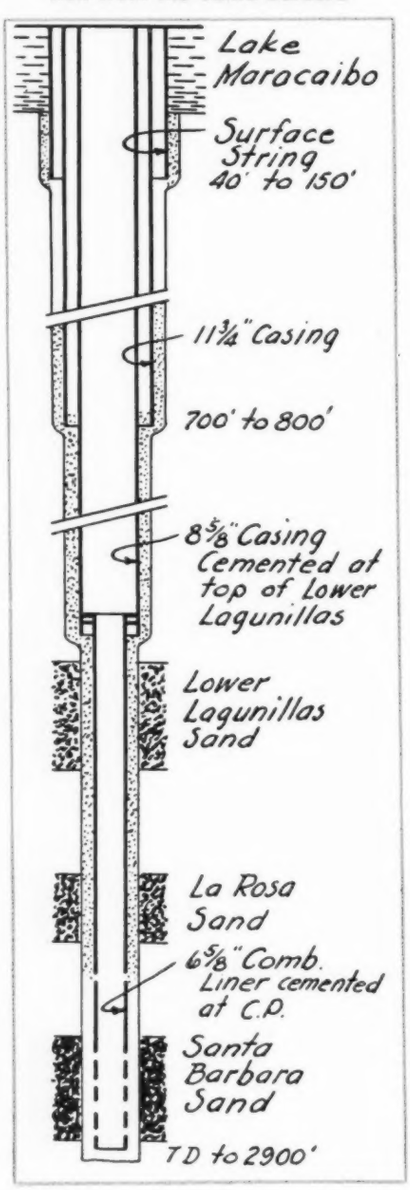
At the present time about 10,000 M cu. ft. comes through 8-in. lines from flow stations to this compressor station. It is equipped with five opposed-type, horizontal compressors, each with two cylinders and driven by a 600-hp. synchronous motor. Of these compressors, two have two 28-in. cylinders each and compress the incoming gas from zero to 50 lb.; two have two 14-in. cylinders each that provide intermediate-stage gas that is compressed to 250 lb.; and one has two 8-in. cylinders that compress the gas from 250-lb. to 850-lb. pressure.

The first-stage gas at 50-lb. pressure goes to the absorption plant through two 8-in. lines laid on the Lake bed. At the absorption plant the gas is stripped and part of the residue taken off for fuel. About 4500 M cu. ft. of stripped gas is used for fuel and is carried to shore through 6-in. and 8-in. lines. It is there picked up by a 10-inch line. This line could not be laid on the lake bottom from the absorption plant to shore because gas lines larger than those of 8-in. heavy pipe will float.

The remainder of the residue gas is returned through a 14-in. line laid on a pier connecting the compressor station with the absorption plant. It is then compressed to intermediate stage. The first-stage gas is cooled en route to the absorption plant by the Lake water but the intermediate stage has to be cooled by a system built at the end of the compressor station. After cooling, the gas goes to the high-pressure unit where it is compressed to 850-lb. pressure.

The high-pressure gas then goes through 4-in. lines laid in the water to a control station where it is distributed to wells for repressuring. This distribution is also through 4-in. lines. The gas is injected into the La Rosa sand through six input wells at pressures ranging from 350 to 450 lb. and into the Santa Barbara sand through seven input wells at pressures from 450 to 750 pounds. These 13 key wells are at carefully selected points over the northern fields. At the control house the lines are manifolded so that gas of either high or intermediate pressure can be taken to each well. The manifold system is made up complete as a unit that can be picked up by crane on a barge.

Fig. 5. Casing program for wells at La Rosa and Punta Benitez fields. The liner is perforated opposite the Lower Lagunillas, La Rosa, or Santa Barbara sand—in whichever the well is completed. The one shown is for production from the Santa Barbara



The above compressor station and absorption plant are some distance apart and are connected by a pier built on concrete piles. At some stations, such as Lagunillas No. 1, the compressor station and absorption plant are consolidated, together with a flow station of the larger type. All gas at such a layout does not come from one flow station. Additional compressor capacity at any station can be provided by the erection of additional housing facilities, as is the case at Compressor Station No. 1.

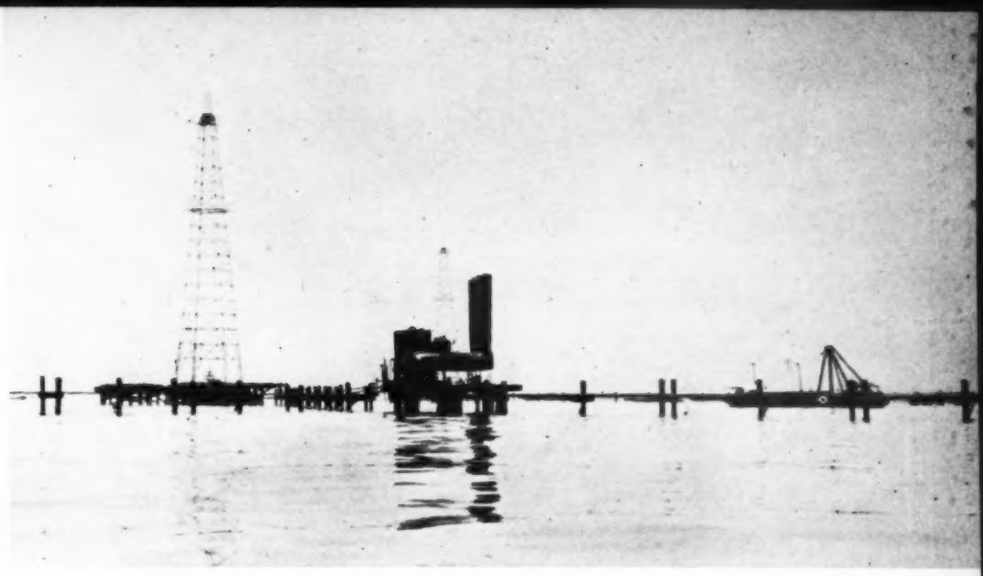
All natural gasoline plants are of the absorption type and are designed to take up as little room as possible without interference with operating efficiency. The general construction can be seen in an accompanying photograph of Absorption Plant No. 1 at Lagunillas. All plants are most modern, automatic control being utilized extensively to facilitate operations.

Laying Pipe in the Lake

The laying of pipe lines in the Lake has developed a definite technique and has necessitated the design of equipment especially adaptable for the purpose. The lines are all-welded and are coated with an enamel for protection against deterioration of all kinds. The maintenance of such lines, laid on the bottom of the Lake and probably settled into silt, is quite likely to be no greater than for lines laid above ground and certainly is not so great as that of lines buried in the ground at many localities. The protective coating is applied on shore and the pipe is made up in 80-ft. sections before being loaded on the barges for pipe-line work.

The pipe-line barge is equipped with a cantilever arm that extends beyond the stern end of the barge and provides for handling two 80-ft. lengths of pipe. In laying a line, one 80-ft. section remains on the barge joined to the line already made up and extending into the water where it has been

(Continued on page 85)



Boiler station of Mene Grande Oil Company, situated to provide steam for several drilling locations on the Lake

(Continued from page 82)

laid. Another 80-ft. section is placed on the cantilever arm and welded to the section on the barge. With this joint connected, the barge is pulled ahead by anchors or pushed forward by using the pipe as a pole. The next 80-ft. section is then put in place and the procedure repeated.

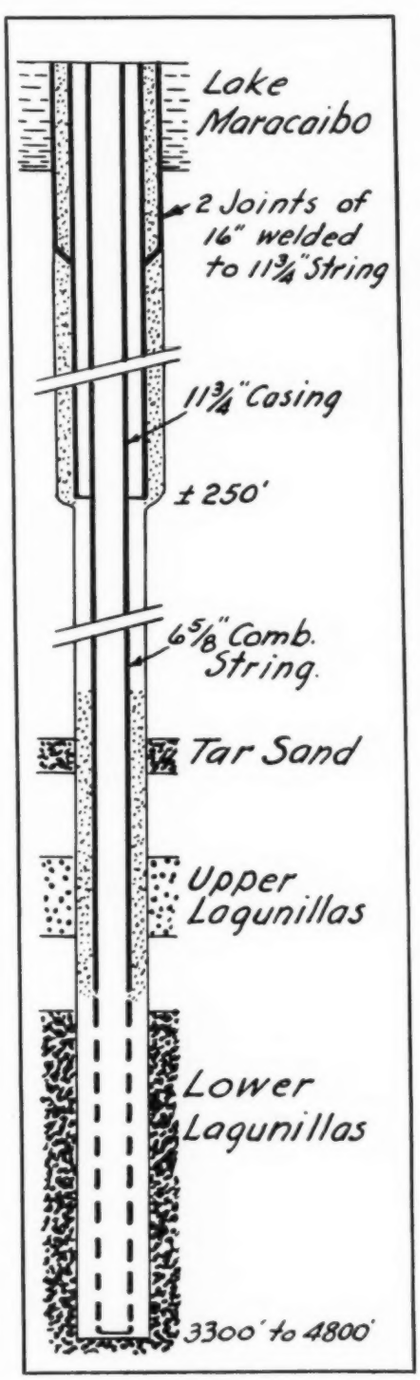
The welded joints are treated with a coating material before they enter the water and any cracking of the enamel at the joint caused by welding is thus repaired. In deep water the line is lowered by a boom at the front of the barge. When using this boom the pipe is supported on a U-shaped roller that allows the line to take off without injury from the barge as it moves away.

The largest size oil line laid on bottom is 10-in. diameter and the largest gas line is 8-in. diameter. Larger oil or gas lines than these will float. In laying a 10-in. oil line, usually from a flow station to shore, the general practice is to begin the line at the shore end and work out. The pipe will float near the surface as it is being laid but floating markers are attached at frequent intervals to aid in keeping the laid portion in sight. After the line is completed to the flow station it is filled with water to sink it to bottom. The connections are then made and the water displaced with oil.

Land Plants for Lake Operations

All the Lago Petroleum Corporation operations on the Lake employ electric power, except those conducted from portable floating equipment such as drilling and pile-driving barges that use steam and other barges or boats using gasoline engines. This power is supplied from a generating plant at Punta Gorda with a capacity of 15,000 kva. (See Fig. 3). The current is transmitted to all fields by power lines carried over the lake and supported by structural steel erected on concrete-pile foundations.

Service lines take off from the main transmission line to supply current for pumping wells, flow stations, compressor stations, and absorption plants. Generally these service lines are through submarine cable although conditions sometimes make it desirable to use overhead lines. Transformers are installed at the place where the power is to be used and the current stepped down to whatever voltage is necessary to service the equipment.



In addition to the offices and warehouses situated at La Salina and Lagunillas, several additional plants of an industrial nature have to be maintained for Lake operations that are not necessary where wells are drilled on land. Among these are the pile-casting plant, dry dock for marine equipment, and launch and small boat repair docks. At the shops at La Salina, boats of considerable size powered with Diesel or gasoline engines can be built complete although practically all such equipment is purchased in the United States and other countries.

The inventory carried by all companies is naturally large; tools and machinery must be available for use at the Lake, for they cannot be delivered by manufacturers on short notice. Main offices of the three companies operating the Maracaibo Lake Fields are in the city of Maracaibo, which is on the western shore of the Lake about 20 nautical miles north of La Salina.

As most of the oil produced by the Lago Petroleum Corporation is shipped to Aruba for refining, that by the Venezuela Oil Concessions to Curacao, and that by the Mene Grande Oil Company to the terminal at Las Piedras, products manufactured by the refineries at the Lake Fields are chiefly for local consumption. Lago has a topping plant at La Salina with a capacity of 5000 bbl. a day and Mene Grande operates a smaller one at Cabimas with a capacity of 2000 bbl. a day. The oil remaining after skimming at these two plants is classified as fuel oil and is shipped out as such.

Fig. 6. Typical casing program for wells completed in Lower Lagunillas sand at Lagunillas and Tia Juana

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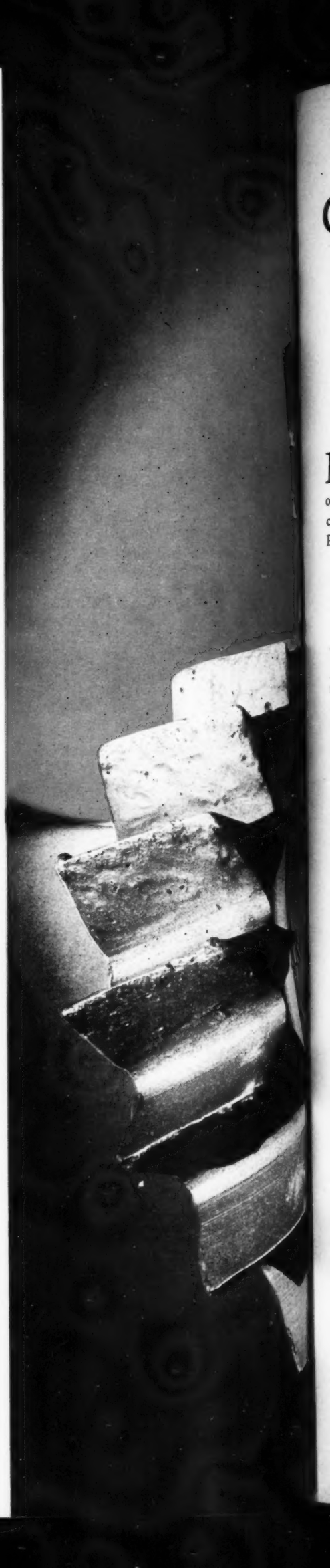

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Other Fields in the Maracaibo Basin

Many wells have been drilled and several fields developed in the area, which extends from the Paraguana Peninsula on the east to the Colombian border on the west

MANY wells have been drilled and a number of fields developed in that area known as the Maracaibo Basin, which extends from the Paraguana Peninsula on the east to the Colombian border on the west. In about the center of this territory is Lake Maracaibo, with its prolific lake fields lying along the northeasterly shore. Actively producing fields, however, lie inland from the lake on both sides, oil for export being piped to terminals on the lake for shipment in tankers. The general locations of the fields are shown on the map entitled "Present Producing Fields of Venezuela."

The Mene Grande Field

LYING southeast of the Maracaibo Lake fields and approximately ten miles inland from its port at San Lorenzo on the Lake, the Mene Grande field covers a proved area of almost 6000 acres. (See Fig. 1 of "Maracaibo Lake Fields Remain a Big Factor in Venezuela's Production."). Operations in this field are carried on by the Caribbean Petroleum Company, one of the Royal Dutch Shell Group. The oil ranges in gravity from 15 to 30 deg. A.P.I. and comes from two horizons. The upper is in the younger Tertiary from which the greater part of the production is obtained.

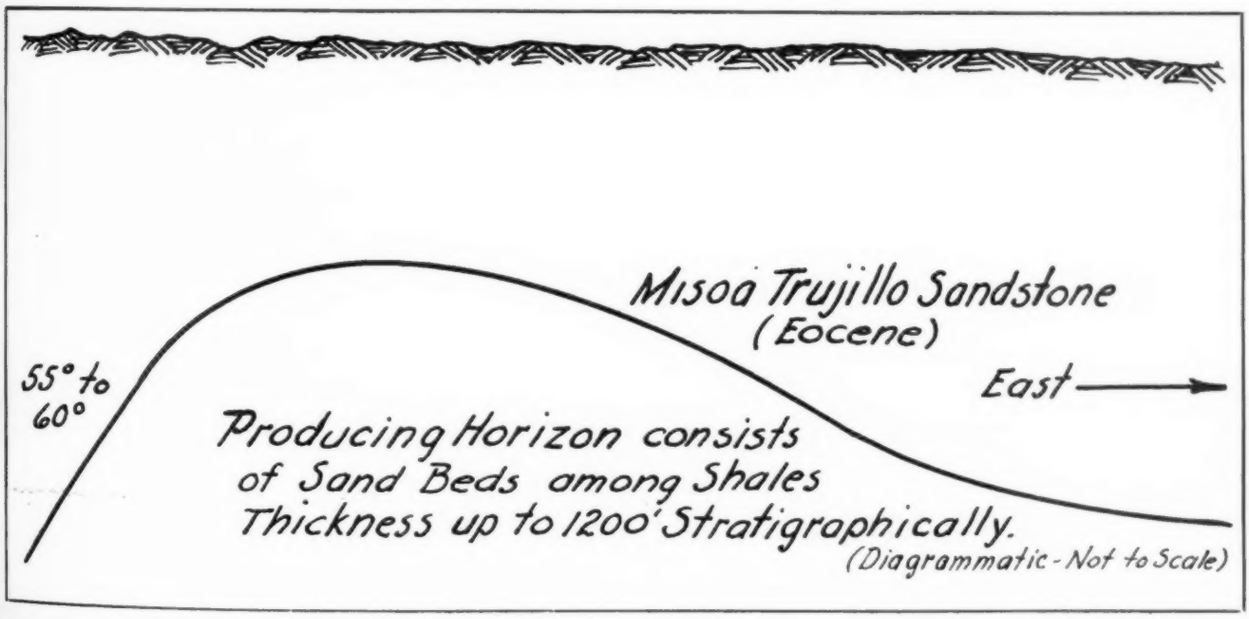
The correlation of the upper horizon is not always clear but in the Eocene there is a definitely identified zone. The oil here is found in a sandstone called the Misoa Trujillo, which takes its name from the mountains near-by. As indicated in the sketch on this page, the structure is a plunging nose with a westerly dip of 55 to 60 degrees. In the upper horizon the reservoir is sealed by asphalt at the outcrops but the limits of the productive area have not yet been reached on the west flank.

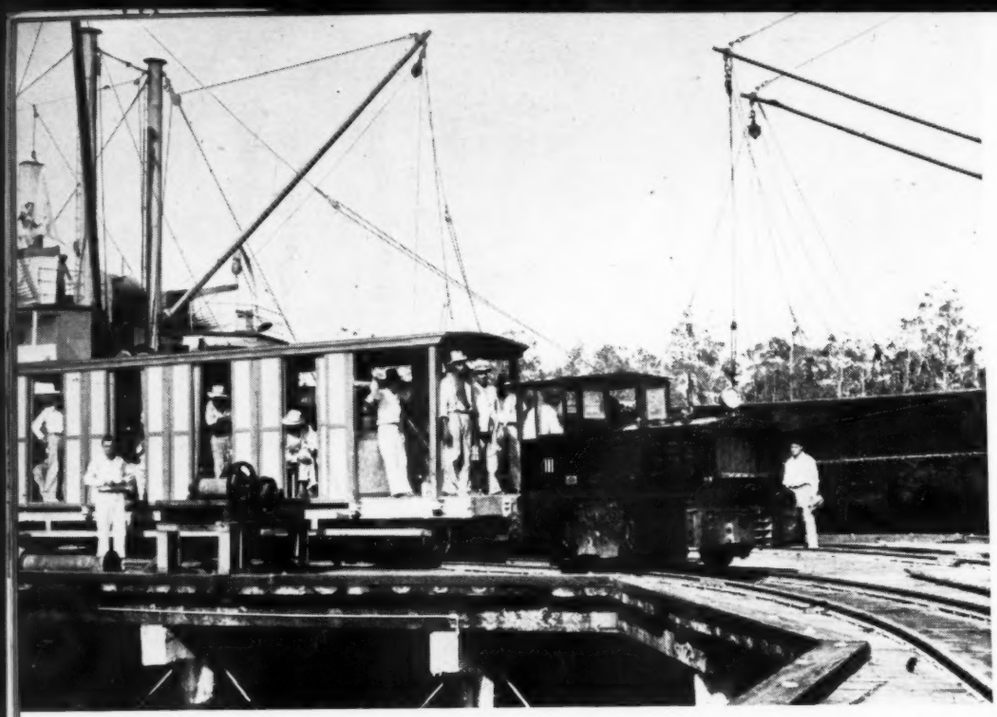
Although the average depth of wells drilled to date is approximately 2400 ft., completions in the Eocene are made at depths of from 2000 ft. to 5000 ft. The upper producing horizon consists of shales with intercalations of sand and stratigraphically it extends in thickness up to 1200 feet. In wells drilled on the west flank, of course, the actual measured penetration through this horizon may be considerably greater. The lower producing horizons consist largely of hard sandstone with intercalations of hard shale.

Six strings of tools now are in operation. No high pressures are encountered and the pressure in the Eocene is approximately 1600 lb. per sq. inch.

The mud used ranges in weight from 80 to 85 lb. per cu. ft. and is treated with sodium silicate. The sand is dropped out and the mud then

Sketch indicating structural condition of the Mene Grande field





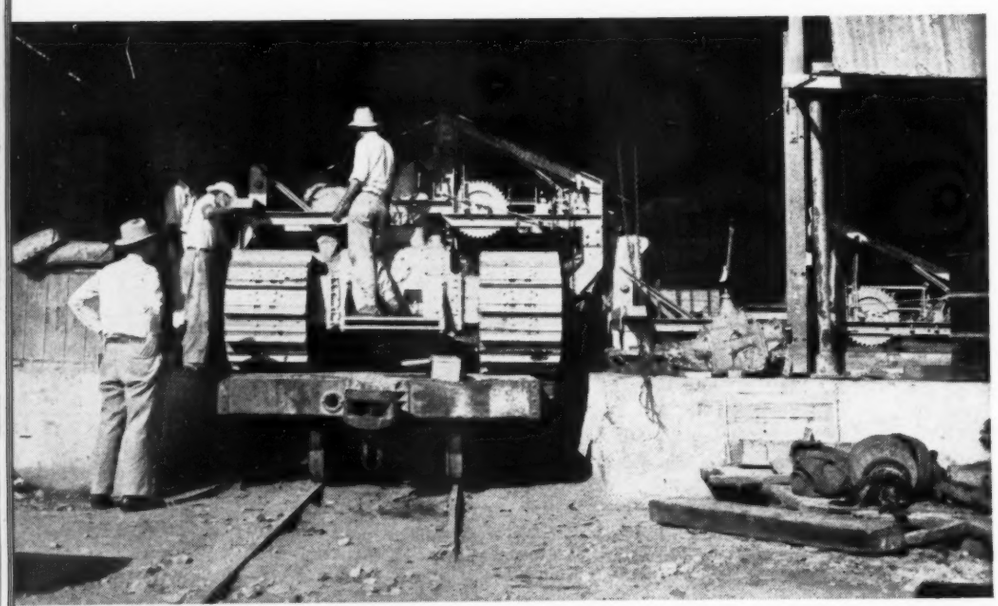
Showing how Venezuela oil field workmen are transported by train

brought back to condition again. A central mud plant is employed for drilling operations and the mud that is here mixed is pumped to the drilling location. The spent mud is discarded. When it is necessary to prevent mud losses in the hole, various compounds are used with the mud fluid. This has been found a successful procedure under conditions encountered in the Mene Grande field. A temperature as high as 70 deg. cent. (158 deg. fahr.) is sometimes found in the Eocene, but no trouble has been experienced in cementing, either for this or other reasons.

No specific casing program can be established for the entire field as water shut-offs are not always known in advance of drilling. The water string, however, usually is 8⅝-in. casing but some 11¾-in. casing strings are used. Some of the wells require two shut-offs. Generally, the liner is of 6⅝-in. flush-joint pipe and on the steep slope to the west frequently is from 800 ft. to 1600 ft. in length. The sand is very fine and slotted pipe is used opposite the productive zones.

Wells are all logged electrically but mechanical coring also is done because the steep slope encountered on the west flank makes identification of strata difficult.

A number of the old wells are being deepened to produce from the lower



Assembling a wide-tread, side-boom tractor, used in oil field work

sands of the upper producing horizon and gun-perforated against blanked-off sands. Although the procedure has not yet been followed, there is a possibility that the method may be given a trial of cementing the liner or casing through the entire thickness of the productive horizon and then perforating for production at strata determined by electrical logging and coring.

It is only recently that it has become necessary to put any of the wells on the pump. A number of wells are on gas-lift and gas for this operation is delivered from the compressor plant at a pressure of 310 lb. per sq. inch. The compressor plant is a deep cool-

A twin location with one well flowing from the upper zone and the other from the lower zone

ing type of gasoline extraction and is equipped with 28 compressors, each of 180-hp. capacity. It also supplies gas to the refinery at San Lorenzo through a 4-in. line. Water for plant operation and for all field uses is taken from water wells in the field. The refinery and ports are supplied with water partly from the Lake and partly from Rio Motatan.

A dehydration plant for treating the oil now is being planned. Crude oil produced at Mene Grande is pumped through two 8-in. lines and one 6-in. line to the refinery and port at San Lorenzo.

The refinery at San Lorenzo has a capacity of approximately 15,000 bbl. a day but a new Trumble plant will be erected to handle an additional 10,000 or 13,000 barrels. The refined products are marketed in Venezuela and are shipped to various points in the country from San Lorenzo. Propane recovered from stabilizing gases is bottled at the plant and sold in northern Venezuela under the name of Shellane.

Production in Colon District

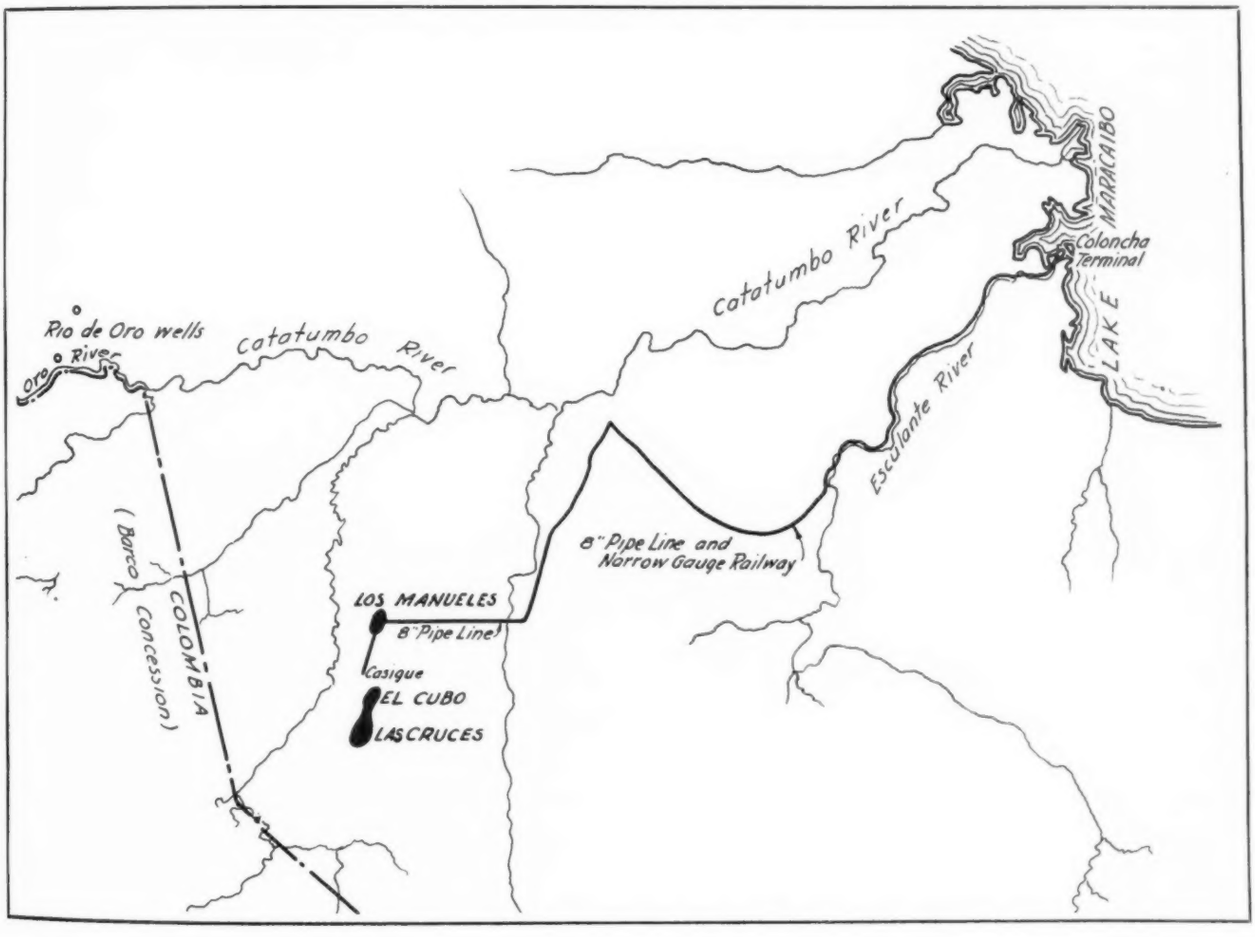
PRODUCTION in the District of Colon is obtained from three areas now developed on a long anticline known as the Tarra Anticline. The most northern of these is Los Manueles and some distance to the south are El Cubo and Las Cruces. The latter two adjoin but evidently are separated by a saddle. The general location of the Tarra Anticline, lying approximately 65 miles southwest of the south end of Lake Maracaibo, can be seen in Fig. 1 (p. 67) of article entitled "Venezuela—An Increasingly Important Factor in World Production," and the relative position of the structures is indicated in Fig. 2, page 96.

Exploitation of the Tarra Anticline is carried on by the Colon Development Company, Ltd., one of the Royal Dutch Shell Group. Production from the three developed areas is approximately 12,000 bbl. daily, which is pumped through an 8-in. line to Solita (or Coloncha) on Lake Maracaibo. From here it goes by tanker to Curacao.

Wells on all three structures are completed in the Eocene. The geological conditions at Las Cruces, however, are unusual as is indicated in the sketch, which shows the overthrust and underthrust encountered in the producing horizon. Production is obtained from one zone in the overthrust and from three in the underthrust. Final well depths in the overthrust horizons are as shallow as 700 ft. and in the lowest sand of the underthrust as great as 5000 feet. The present production from Las Cruces is approximately 9000 bbl. daily.

(Continued on Page 94)

Fig. 1. Means of access to the Barco Concession in Colombia from Lake Maracaibo can here be seen, the Catatumbo River providing for shipment of materials during the rainy season. Producing areas on the Tarra Anticline in the Colon District of Venezuela also are shown



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MAKE 150 BARRELS
OF EXCELLENT
DRILLING MUD
AQUAGEL

(Continued from Page 91)

The production from El Cubo is between 600 and 700 bbl. daily. The combined productive area as now proved for El Cubo and Las Cruces is approximately 750 acres.

At Los Manueles no underthrust is yet known and the proved productive area covers approximately 250 acres. Production from this structure is approximately 2000 bbl. daily.

The combined storage at Casigua (situated between the El Cubo and Los Manueles structures) and at Coloncha on the Lake is about 500,000 barrels. The oil is treated by chemical dehydration. Although the air line distance between Casigua and Coloncha is but little more than 60 miles, the pipe line connecting them is approximately 90 miles in length. Its construction was difficult, as it passes through swamps and jungle.

Rio De Oro

THE Shell interests also have explored the Rio de Oro on the Venezuelan side of the Venezuela-Colombia boundary. In one well drilled to 1653 ft., 27-deg. A.P.I. oil is reported. Another well from which is obtained approximately the same gravity oil was drilled to 3105 ft. along the river and approximately eight miles north. At the present time further exploration work is being carried on east of the river. The general location of these wells is indicated on the map (Fig. 1, p. 67) entitled, "Present Producing Fields of Venezuela," although they are not on production at the present time. Very much more production will have to be developed before a means of transporting the oil over extremely difficult country can be justified.

Fields West of Maracaibo City

AS shown in Fig. 1, below, the fields of La Paz and La Concepcion are connected with Lake Maracaibo by a 6-in. pipe line. Both areas are operated by the Caribbean Petroleum Company, most of the oil being exported at the present time coming from Concepcion. The oil from this field has a gravity of 37 or 38 deg. A.P.I. and is produced from depths of approximately 1850 feet. The La Paz is an old pumping field where the wells average less than 1500 ft. in depth and the oil is of a gravity ranging from 22 to 30 deg. A.P.I. As reported by C. C. McDermond, there are 75 pumping wells at La Concepcion and three at La Paz at the present time.

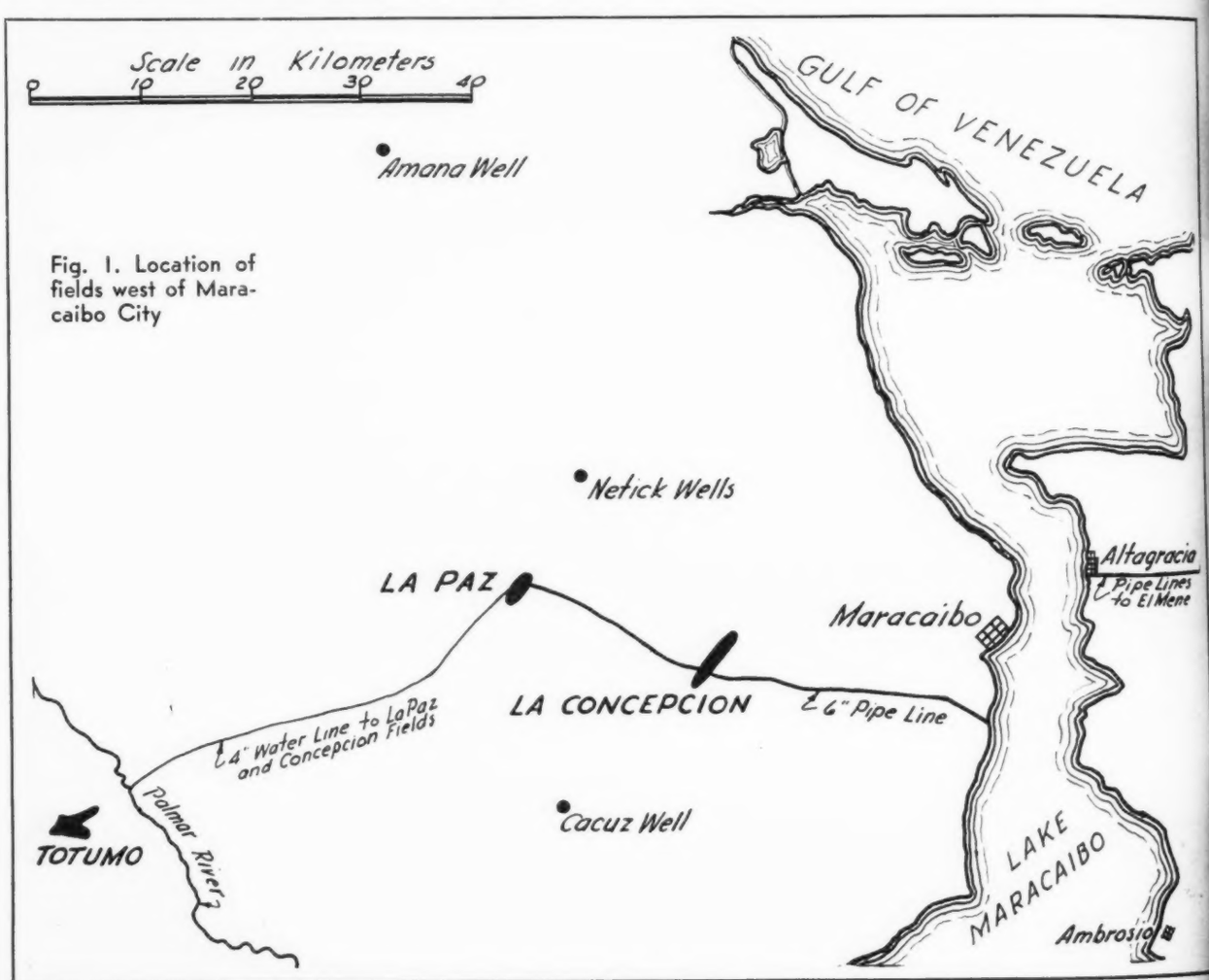

Fig. 1. Location of fields west of Maracaibo City

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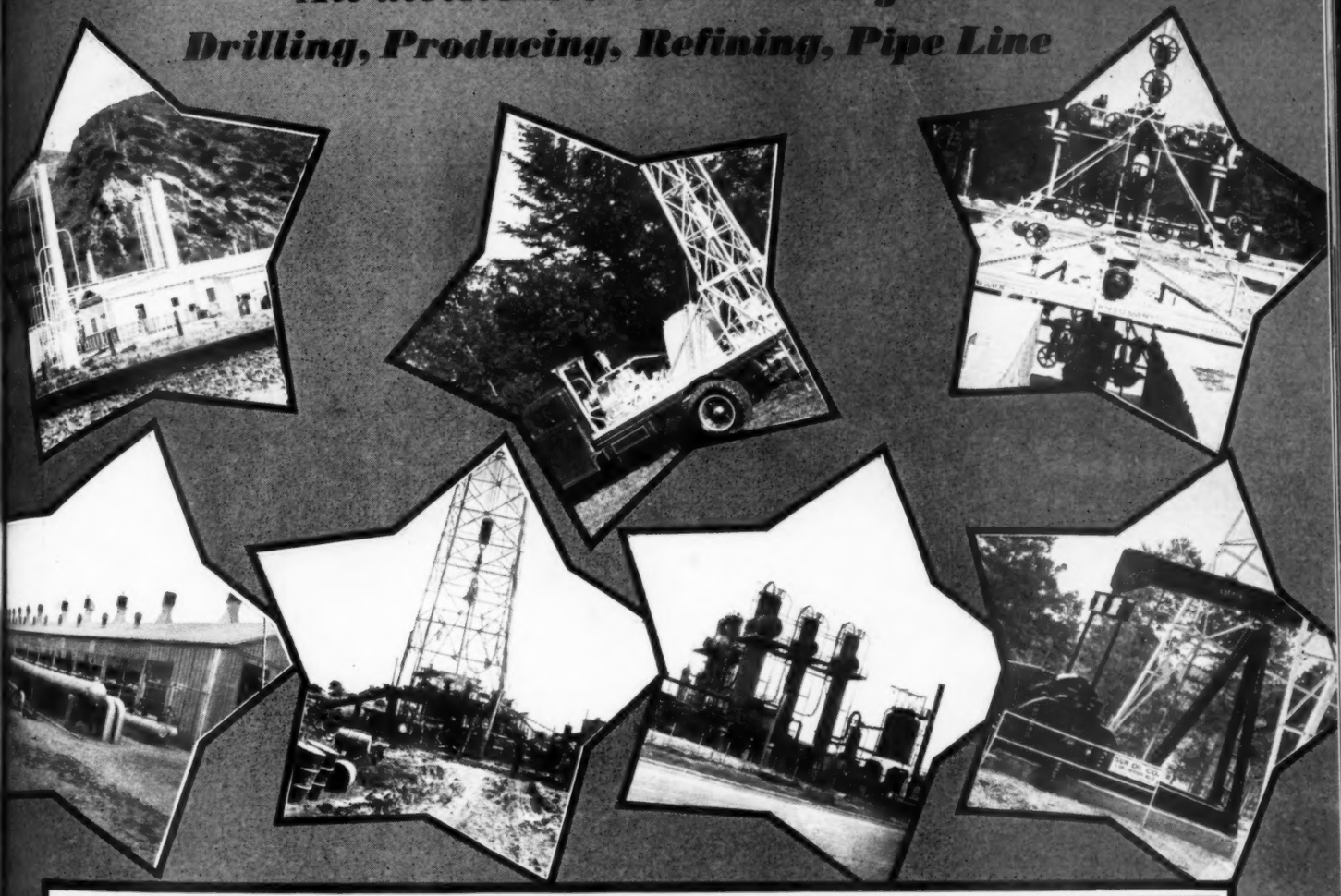

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A street in a Venezuelan village

No other oil is being produced from this area west and north of Maracaibo at the present time, although 20 deg. A.P.I. oil is reported in wells drilled in the Totumo field to a depth of slightly more than 2100 feet. A well just north of this field and another just south were drilled to depths of 1619 and 3233 ft., respectively, and procured the same gravity oil. Approximately 40 kilometers north of La Paz the Amana well found 31 deg. A.P.I. oil at 3840 ft., and 12 kilometers east of this Vemor No. 1 was drilled to a depth 5364 ft. and found 12 deg. A.P.I. oil. In the Netick wells ten kilometers northeast of La Paz, oil of a gravity ranging from 28.5 to 31 deg. A.P.I. was found at depths from 4880 to 5365 feet. Approximately 20 kilometers southwest of La Concepcion, 11 deg. A.P.I. oil was obtained from the Cacuz well drilled to a depth of 6273 feet.

In other wells scattered over this area, oil and gas showings have been encountered at depths ranging from less than 1000 ft. to nearly 7000 feet. In some of these igneous rock was encountered and all since have been abandoned.

Fields East of Maracaibo City

LYING slightly more than 50 kilometers east of the lake at Altagracia is the El Mene field, approximately eight kilometers northeast of this is the Media field, and ten kilometers farther is the Hombre Pintado field. (See Fig. 1 of article entitled "Maracaibo Lake Fields Remain a Big Factor in Venezuela's Production.") Operation of these fields is by the British Controlled Oilfields. The average well depth in the El Mene field is 1020 ft. and the gravity of the oil produced ranges from 35 to 43.5 deg. A.P.I. In the Media field the average depth is 3272 ft. and the gravity of the oil is 39 deg. A.P.I. Gravity of the oil from the Hombre Pintado field, however, is only 19 to 29 deg. A.P.I. and the wells average 2021 ft. in depth. Oil taken from the three fields is piped to a terminal at Altagracia, which lies on the lake across from Maracaibo. A 6-in. line runs from Altagracia to El Mene and a 4-in. line parallels this and extends to the Hombre Pintado field.

South of the town of Dabajuro are the Las Palmas wells, which, at an average depth of 2559 ft., produced 34 deg. A.P.I. oil. These wells are not producing at present but a pipe line runs from them to the Hombre Pintado field. Numerous wells drilled south of Dabajuro had showings of oil and gas but have been abandoned.

Farther to the northeast a number of wells were drilled around Urumaco and several, at an average depth of 3914 ft., struck 38 deg. A.P.I. oil. One well, however, was drilled to a total depth of 6194 ft. but was abandoned. Another was a gas well and also was abandoned. Several other wells in the surrounding area were drilled to depths ranging from 2000 ft. to more than 6000 ft., and, although showings of oil and gas were encountered in these wells, they have been abandoned.

At La Vela, east of Coro, several wells have been drilled by the Standard Oil Company of Venezuela and one has been completed as a gas well.

To the east and somewhat beyond the Maracaibo Basin proper is the El Mene de Costa field, also known as El Mene del Salto. This area is owned by Tocuyo Oilfields of Venezuela and is a shallow, light oil field with wells averaging 950 ft. in depth and yielding oil of a gravity of 43 deg. A.P.I. A 6-in. pipe line connects it with tidewater at Chichirviche.

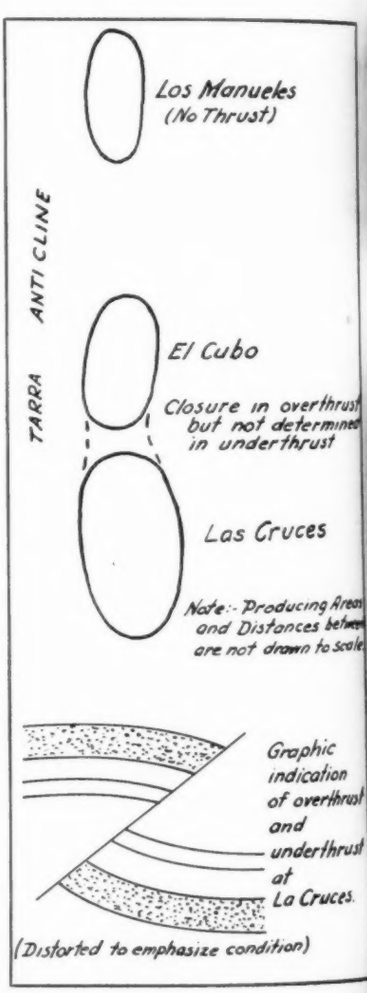
Los Manueles
(No Thrust)
TARRA ANTI CLINE
El Cubo
Closure in overthrust but not determined in underthrust
Las Cruces
Note:- Producing Areas and Distances between are not drawn to scale.
Graphic indication of overthrust and underthrust at La Cruces.
(Distorted to emphasize condition)

Fig. 2. Relative location of producing areas on the Tarra Anticline in the Colon District

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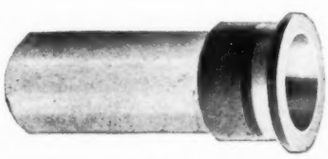

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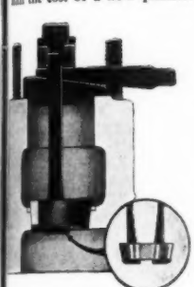


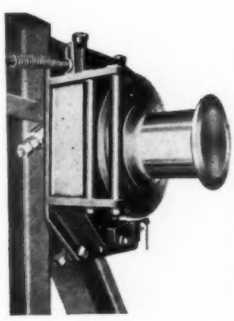
VALVE SEAT PULLERS

Made in two types, wedge type (illustrated), a simple but efficient puller at a low price—three different sizes to fit all types of valve seats. The deluxe puller is built for extreme service of correctly heat-treated metal and exerts a powerful pull on any Cross Bar valve seat.

PUMP LINER PULLERS

A powerful pull and a rigid grip are the outstanding features of the MacClatchie Liner Puller. It is ruggedly built to pull the most stubborn Liner and is made in a complete range of sizes. Specify when ordering.

MacCLATCHIE GEAROMATIC CAT HEAD



Geared two to one this rugged cathead gives twice the pull at half the lineshaft speed. It has a fool-proof kick out device that allows one revolution *only* per pull—eliminating all danger from fouled lines.

MacCLATCHIE "HYDRO-SEAL" PLUG VALVE

Grease expanded lips insure an absolutely fluid tight seal, and a simple turn on the grease screw maintains the seal and completely lubricates the pump. In high pressure models compressible packing is eliminated and ball thrust bearings are used to insure free turning under *all* conditions.

HOLE CONDITIONING TOOLS

Years of experience in building hole conditioning tools have developed MacClatchie Wall Scrapers, Underreamers, and Straightreamers to their outstanding popularity among oil men the world over. In every MacClatchie Hole Conditioning Tool you get the plus performance of triple cutter action—less wear per blade and an absolutely cylindrical hole!

MacClatchie Rotary Underreamer

(Right)

Known the world over for simplicity and fool-proof performance. It is especially desirable for export operators as the wear on the body is absorbed by renewable parts. Its operation is extremely simple and positive!

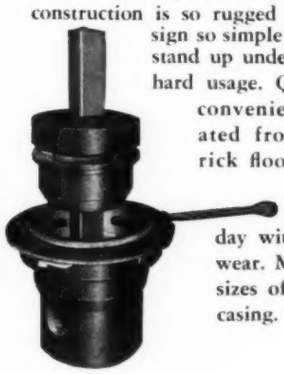
MacClatchie Wall Scraper

(Left)

Three cutters are particularly essential on a wall scraper to give greater strength, insure an absolutely true hole, and to eliminate vibration and tortional strains on drill pipe.

ROTATING BLOWOUT PREVENTER

(for drilling under any mud or gas pressure). Will withstand any pressure encountered in present-day drilling. Its construction is so rugged and its design so simple that it will stand up under extremely hard usage. Quickly and conveniently operated from the derrick floor and may be rotated day after day without undue wear. Made for all sizes of Kellys and casing.



MacCLATCHIE QUICK CHANGE CEMENT HEAD

This Cement Head can be installed or removed from the casing almost instantly. It has the added feature that high pressure only expands the packer more tightly and grips the slip more firmly into the casing.

MacCLATCHIE MANUFACTURING COMPANY

COMPTON, CALIFORNIA ★ HOUSTON, TEXAS ★ EXPORT: GEO. R. WOODS, 17 BATTERY PL., NEW YORK

Eastern Venezuela . . . An Area With Both a Present and a Future

Numerous wildcat tests are being drilled in the area and encouraging prospects are reported

CONSIDERABLE attention is being focused on the oil prospects of Eastern Venezuela. Many wildcat tests have been drilled in this area during the past few years and a number are being drilled at the present time. Rumors, which are rather generously accepted but which have not been confirmed, are that most encouraging prospects have been discovered; in fact, that development of one area soon may proceed on a big scale, and pipe line and refinery construction will keep step with an active drilling campaign. How true this is cannot be definitely stated, but the prospects seem bright for future important discoveries. Several shallow gas wells have been drilled at various locations and geological and geophysical exploration are being carried on over most of the territory. It must be remembered, however, that Eastern Venezuela already is an oil-producing area, one field in which is exporting more than 70,000 bbl. of oil at the present time.

The dense jungle growth, known locally as "monte," makes all geological work in Eastern Venezuela extremely difficult and hazardous. Geophysical prospecting, nevertheless, is being carried on in all the most promising areas; this means of plotting structures probably will expedite the extensive exploration work. The seismograph, torsion balance, and magnetometer all are being used, several different companies employing one or more of these methods in the conduct of surveys.

It is impossible to present an accurate picture showing the locations of wildcat operations. Some wells drilling last month may be abandoned or shut down now; others not even located then may be down to considerable depths by this time. Standard Oil Company of Venezuela has eight wildcat rigs operated by Venezuelan crews with North American drillers, and most of these are in constant use. Two important wells being drilled by these rigs are on the San Juan River east of Caripito and another is near Maturin. The Gulf interests have drilled some important locations and considerable attention is being paid to one of the Gulf wildcats to the west of the tested area and lying between Cantaura and La Canoa.

One well, directly north of Pariaguan and probably the most westerly of the Eastern Venezuela tests, was drilled by the Gulf to a depth of 6207 ft. and is reported as having a shut-in production of 10,000 cu. ft. of gas daily. A report of March 19 by C. C. McDermond of Maracaibo stated liner in this well is being pulled preparatory to deepening.

From the Orocual wells of the Standard Oil Company of Venezuela lying northwest of Maturin a little fuel oil is taken occasionally. From three other wells in this same area a total of almost 30,000 bbl. has been produced since they were drilled; however, this is not commercial production.

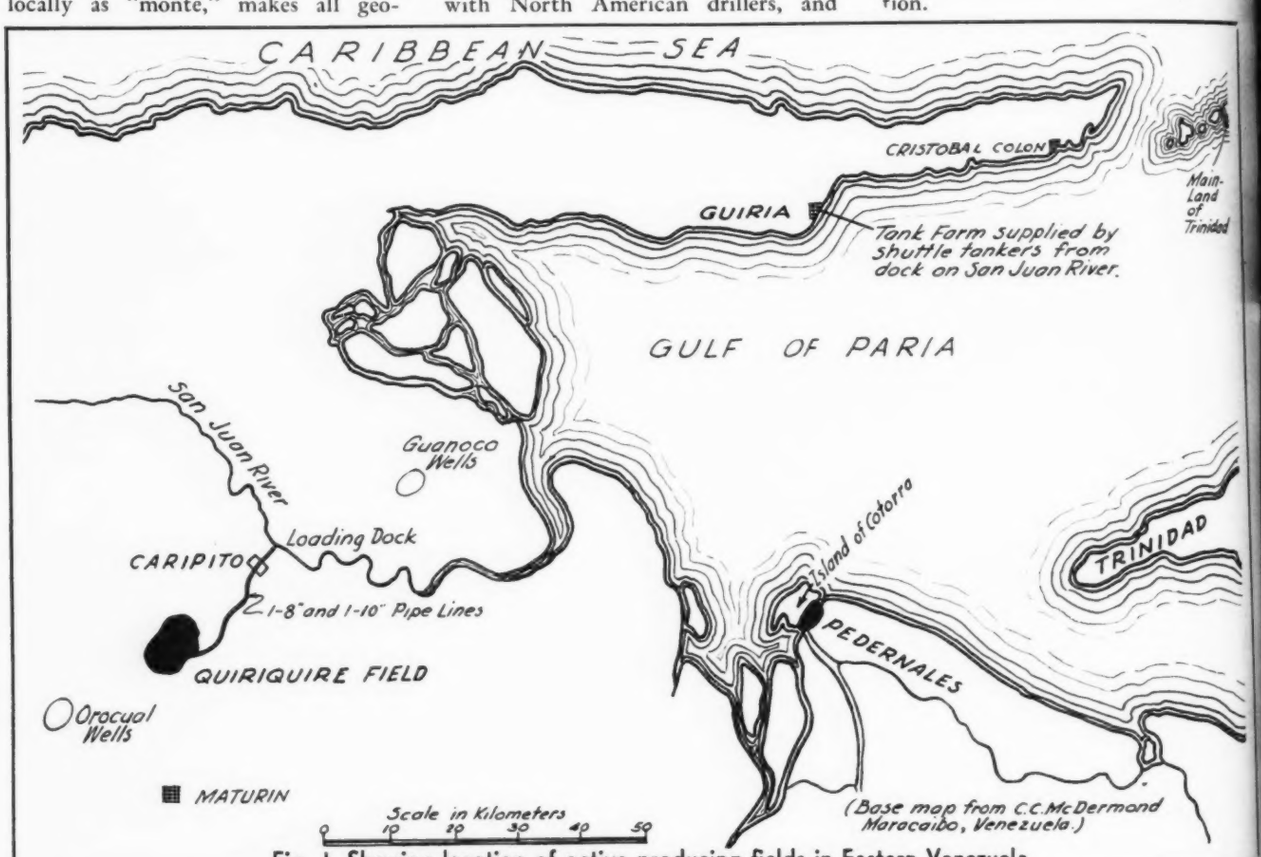


Fig. 1. Showing location of active producing fields in Eastern Venezuela

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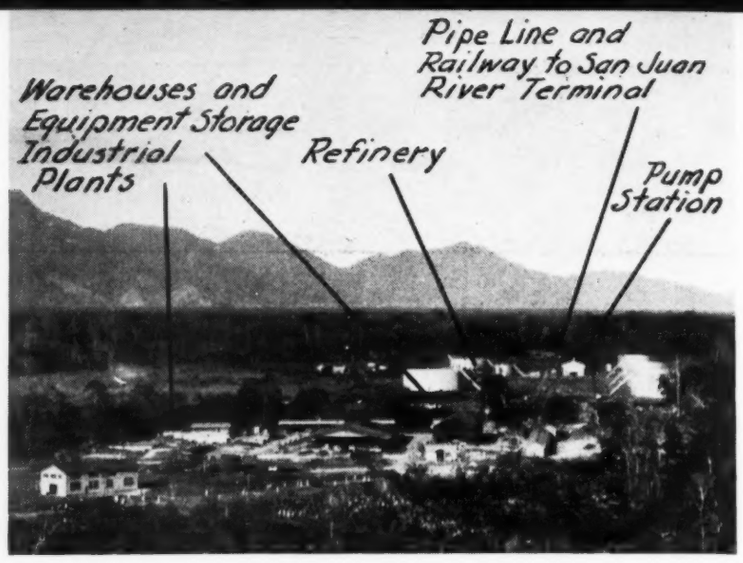
Looking through tank farm and over industrial district at Caripito


Pipe Line and Railway to San Juan River Terminal
Warehouses and Equipment Storage Industrial Plants
Refinery
Pump Station

View from camp of Standard Oil Company of Venezuela

Operations at Caripito

Development of Quiriquire and Pedernales fields, as well as wildcat operations in Eastern Venezuela, are directed from Caripito

ALL oil exported from Eastern Venezuela at the present time is coming from the Quiriquire and Pedernales fields, which are operated by Standard Oil Company of Venezuela. Production from the former is now about 72,000 bbl. daily and from the latter about 2000 bbl. daily. The operations of both fields and of all wildcat work being conducted by the company are directed from Caripito. The locations of Caripito, of the two fields, and of the terminal at Guiria are shown in Fig. 1, of article entitled "Eastern Venezuela—An Area With Both a Present and a Future."

Only oil from the Quiriquire field passes through Caripito whence it is brought to a tank farm through one 8-in. and one 10-in. pipe line. At the tank farm there are five 80,000-bbl. tanks for crude oil storage but one of these can be switched from crude to bunker fuel oil when necessary. In addition, there are two 55,000-bbl. tanks for fuel oil alone. Pumping of the fuel oil to the tanker loading dock on the San Juan River can be done by the refinery but most of it is handled by the pump station.

In the pump station there are three Diesel-engine-driven pumps, two of which are 9½ by 24, each powered by a 185-hp. 14½ by 18 Diesel, the other a centrifugal pump with a capacity of 1750 g.p.m. and powered by a 480-hp. 15 by 18½ Diesel. Three pipe lines transport the oil from the pump station to the loading terminal. One 12-in. and one 10-in. line transport crude and one 8-in. line transports fuel oil. The 8-in. line is used for piping the fuel oil from either the pump station or the refinery.

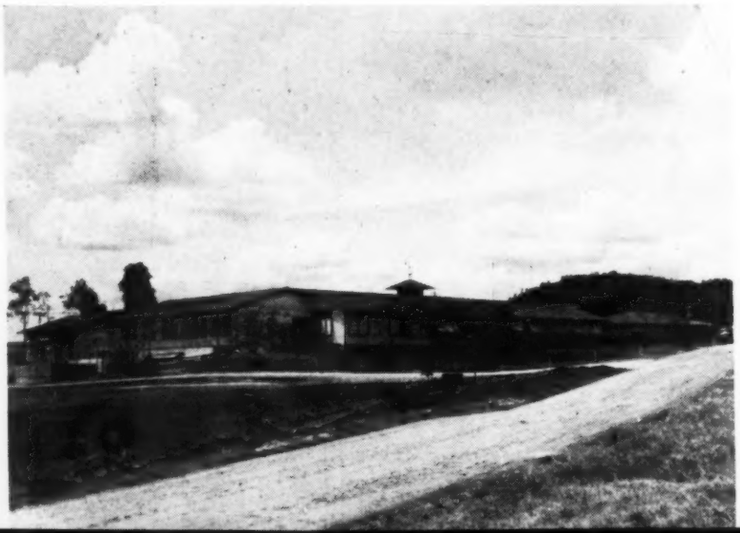
The pipe lines and a narrow-gauge railway run through an opening cleared for about four kilometers straight through the jungle from Caripito to the loading dock on the San Juan River. Gasoline-engine powered locomotives haul trains back and forth over this line carrying men and materials between the two points. At the river the trains run on a trestle built on the swampy shore to the dock where steamers are loaded and unloaded. All equipment for operations at Quiriquire and nearby wildcats are shipped in through the port and all exports of oil from the Quiriquire field are here loaded on tankers.

Tankers are loaded with cargoes up to 40,000 to 50,000 bbl.; they cannot be loaded to deeper draft because of a bar in the river. They then go to Guiria where they are topped from shuttle tankers from the tank farm there. Other ships receive part of or all their cargo at Guiria or direct from shuttle tankers, for the entire loading of a ship can be all or in part from either the tank farm or shuttle tankers.

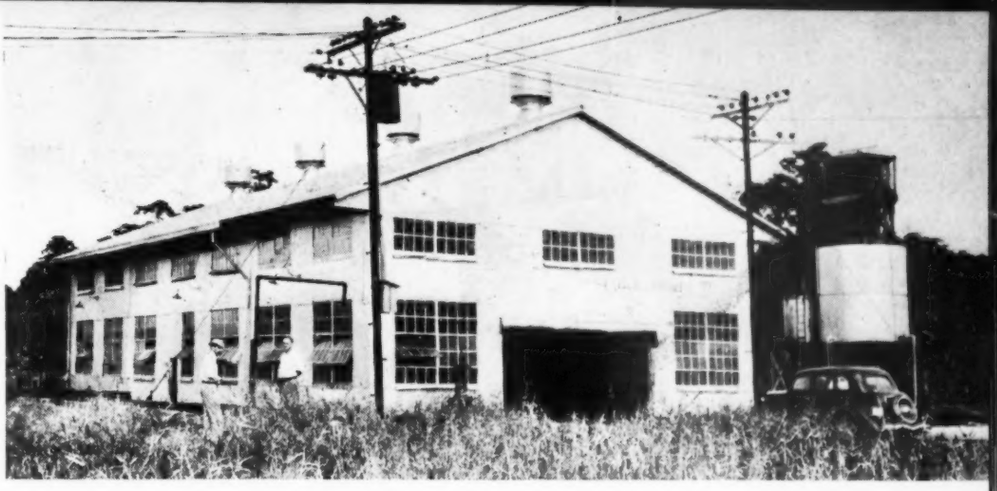
The tank farm at Guiria is supplied with oil by the shuttle tankers. There are three of these ships in service that can take 40,000 bbl. each over the bar. The San Juan River has a tide at Caripito of 14 ft. which is taken into consideration in the scheduling of ships.

The water supply for operations comes from the Rio Caripe about five kilometers from Caripito and is handled by an individual pump station with Diesel-electric drive. Ships are also supplied with this water, which is pumped to the terminal through a 4-in. line.

Main office building, Standard Oil Company of Venezuela, Caripito



The company's operations in Eastern Venezuela are directed from here



Pump station, Carpito, which pumps oil received from Quiriquire field to the tanker loading terminal on the San Juan River

Industrial Section

The offices of Standard Oil Company of Venezuela are at Caripito, which together with commissary, clubhouse, and houses for foreign staff and all employees, are on a plateau above the valley of the San Juan River. Immediately below these are the refinery, pump station, tank farm, warehouses, and shop buildings. Between the camp and the industrial section, the Venezuelan village of Caripito lies on the side of the hill.

The refinery is a 5000-bbl. topping plant and is taking from 4000 to 5000 bbl. of crude per day. Two grades of gasoline, a gas oil, and a fuel oil are now being manufactured and Diesel oil is being blended. Changes are about to be made, however, to process an overhead Diesel fuel taken directly from the tower. Shipments of gasoline and gas oil are made by drum and go mainly to surrounding local markets. Fuel oil is exported by tanker but a considerable quantity is used for bunker fuel.

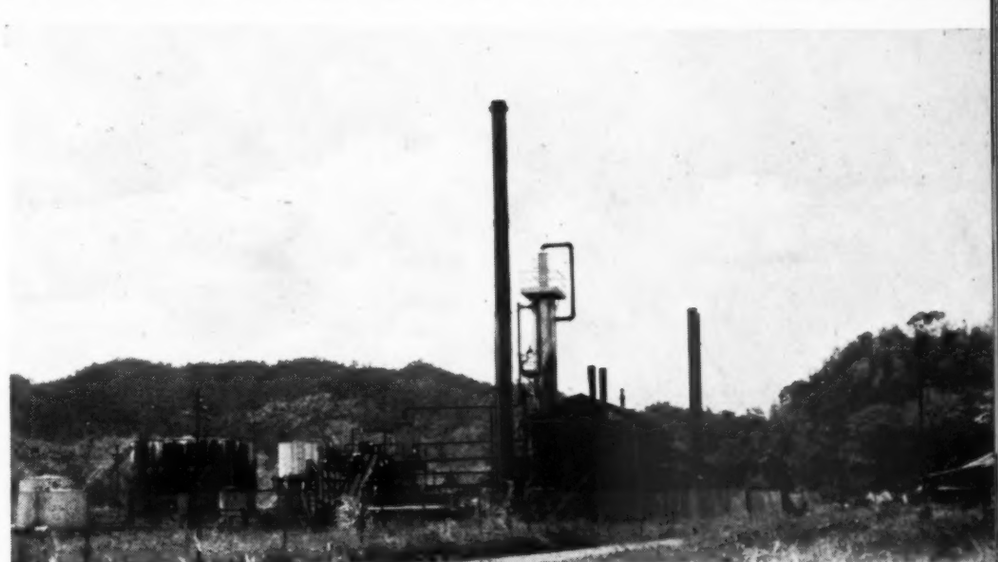
The yields obtained at the Caripito refinery runs on 19 deg. A.P.I. oil are:

Naphtha	3 percent
Gas oil	9 percent
Fuel oil and refinery losses	88 percent

Extensive warehouse stocks are carried at Caripito, tools and machinery being immediately available for all operations to the greatest extent possible. A paleontological laboratory is maintained for analysis of samples from the Quiriquire and Pedernales fields and from all wildcat wells being drilled by the company. Two airplanes are stationed at the airport near the Quiriquire field and are used for covering the company's activities, which include operation of the Cumarebo field. Radio phones connect the Quiriquire and Pedernales fields with the main office at Caripito but wireless is used to the Cumarebo field.

The company is training Venezuelans in all branches of oil operations; it provides schools for the children and trade schools for employees. Training classes in drafting and all kinds of clerical work are also conducted to aid in the advancement of employees in those phases of the petroleum industry. Modern living quarters are made available for all employees in sanitary tile houses built by the company at Caripito and at each field.

A complete and modern hospital is manned by a staff of competent doctors and medical attention is provided to maintain health. Pure water for drinking and bathing is supplied to all. Good, healthful food is provided through the commissary and everything is being done to combat the climatic conditions encountered in Eastern Venezuela where dense jungles have been conducive to a prevalence of fever and other tropical diseases.



The topping plant at Caripito

Tanker coming in for cargo of crude oil at San Juan River terminal

THERE were fifty-seven varieties of Pumping Units on the market (including many "make-shift" arrangements for lifting oil) the last time the statisticians took time out to count them.

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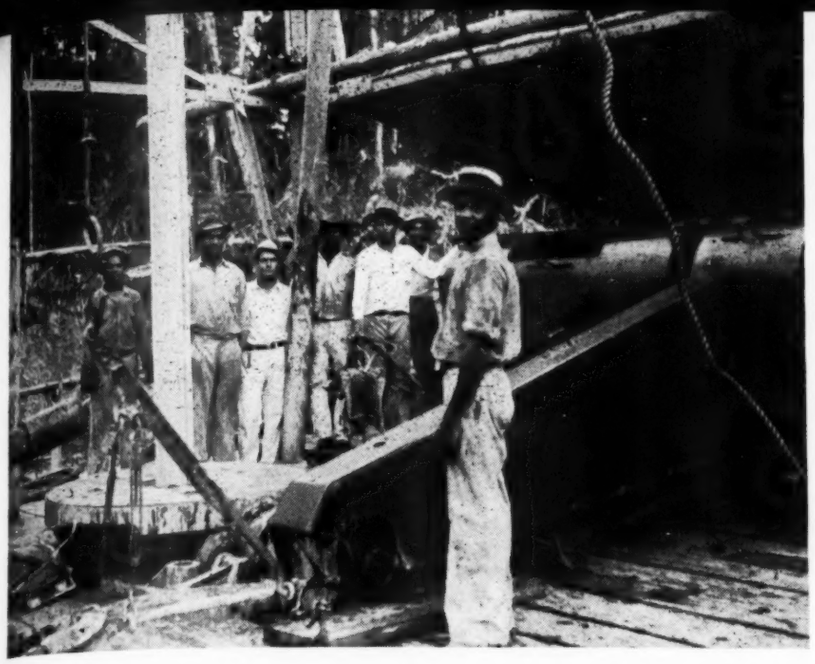
LUFKIN PUMPING UNITS



A drilling crew in the Quiriquire field. The entire crew including driller is Venezuelan

The largest producing area in Eastern Venezuela is the Quiriquire field, discovered in 1925 and actively developed, beginning in 1928

The Quiriquire Field

LYING southwest of Caripito is the Quiriquire field—the largest producing area in Eastern Venezuela at the present time. The discovery of oil was made in 1925 but active development of the field was not begun until 1928. This was in the west segment, where oil of 14 deg. A.P.I. gravity is produced. In 1930, however, a well drilled in the east segment on the other side of a fault produced oil of 19 deg. A.P.I. gravity and more active development followed.

The structure is monoclinal and production is obtained from various beds. The oil zones are lenticular and composed chiefly of fine and coarse sands. These are rather unconsolidated and contain cobbles and boulders and intercalations of shales and sandy shales. The producing horizon varies from 100 to 1400 ft. in thickness.

A north-south fault divides the field into two parts, designated as the west segment and east segment, as shown in Fig. 1.

In the east segment there are two distinct producing zones, separated by a shale bed, that are produced in most cases from different wells by the use of twin locations. The greater amount of oil comes from this area. In the west section there is only one zone, the oil from which is of lower gravity than that on the other side of the fault.

Drilling

Five rigs are running in the Quiriquire field and all wells are drilled by crews made up entirely of Venezuelans operating under the supervision of an American tool pusher. Most of the locations have to be cleared from the "monte" (jungle growth) and steam shovels are necessary in preparing many of the well sites. Three 90-hp. steam boilers of 150-lb. working pressure are used and are set at any convenient position away from the rig where, in the case of a twin location, they can serve both wells.

Although equipment now being used for drilling has given satisfactory service, numerous changes are contemplated. Two 10 by 4½ by 10 feed pumps are being used but fuel pumps will be unitized on skids with a light generator. The mud pumps consist of one 12 by 6 by 16 and one 14 by 7¼ by 18 pump mounted on Athey wagons equipped with caterpillar-type treads. These are moved up to a location to be drilled, and are very advantageous for handling twin locations. One of the pumps is a standby. The drawworks is of the light-duty type and the engines are all 10 by 10.

In drilling, fish-tail bits are used to a depth of about 2000 feet. After the conglomerate is reached, the cutting is somewhat difficult and is hard on any type of bit. Drag bits have been used to some extent but the present practice is to use the roller-type rock bit. Down to about 2800 ft., 6⅝-in. drill pipe is used after which it is replaced by 4½-in. drill pipe. Table speed is maintained at approximately 80 r.p.m. under average conditions.

Only one cellar control gate has been found necessary to provide the necessary control during drilling. The weight of drilling mud used is from 75 to 95 lb. per cu. ft. and is made with native clay, augmented by mud from the well. Weight materials are seldom added. A compound and caustic soda are used to thin the mud when such conditioning is necessary. The viscosity is kept at 45 seconds by Marsh viscosimeter.

In drilling twin-location wells, the first well goes through the entire productive horizon and all producing sands are cored. As shown in Fig. 2, casing and a liner are set to produce the lower zone in this well. In the second well it is not necessary to core, the location of the shale break between the upper and lower zones and other data being known from the cores of the first well, which is only 30 ft. distant. The second well is not drilled beyond the shale but casing and liner are set for producing from the upper zone. Total depth of upper sand wells average 2500 ft.; lower sand wells about 3000 feet.

While the first well is drilling, the

A drilling well, Quiriquire field

The largest pump station in the Quiriquire field. Production from 23 wells is handled by this station—a volume of 40,000 bbl. daily. The pumps are steam driven and are situated in the same building as the boilers, shown on the right

derrick for the second well is erected and lights and crown block installed. After the first well is completed, the engine, drawworks, table, and rest of the rig are moved over and all connections changed. The boilers remain in the setting used for the first well and the pumps, mounted on the Athey wagon, are placed where desired. The derrick for the first well is then moved off.

The casing program for the twin wells is shown in Fig. 2. All wells are logged electrically as well as cored in the manner already stated. At the present time a surface string of 13⅜-in. casing is cemented at 300 ft. from bottom to top. It is sometimes difficult to get returns at the surface in cementing this string so, if it is impossible to cement entirely from the bottom, the job is finished from the top. The 8⅝-in. string is cemented in the regular way from the shoe with 250 sacks of cement. This brings the cement well above the top of the upper zone in the wells producing from lower zone.

Experiments probably will be made shortly using a 11¾-in. surface string and then drilling to bottom where a 6⅝-in. combination string will be run with perforations opposite the producing zone and cement behind the pipe above the casing point. This method, if followed, will eliminate the 4¾-in. perforated liner, which is now hung in the 8⅝-in. water string.

Production and Utilization of Gas

Of the 200 wells completed to date in the Quiriquire field, all but 29 are flowing. In completing, the mud is readily washed from the face of the sand and the well flowed through the tubing. All flowing wells are beaned and back pressure is held on the sand.

The aim of the company in producing the field is to maintain the greatest efficiency possible and obtain the highest ultimate yield. The company prorates itself, production controlling the tanker schedule instead of the tanker schedule governing production. The gas/oil ratio at present averages about 208 cu. ft./bbl. and there is no free gas, it being conserved to the utmost.

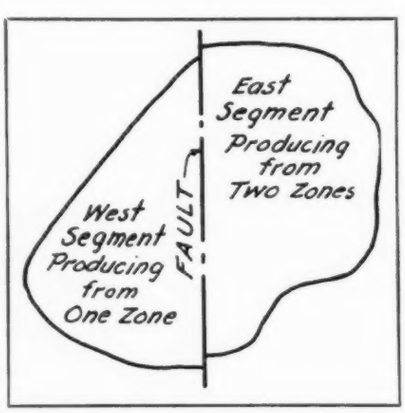


Fig. 1. Approximate outline of the Quiriquire field showing the two segments into which the field is divided for operating purposes

The rate of production is controlled by bottom-hole pressure and gas/oil ratio. The bottom-hole, tubing, and casing pressures are watched carefully and when the gas/oil ratio becomes excessive the well is pinched in. The production is also choked back when the differential pressure is high and when the closed-in bottom-hole pressure shows an excessive drop. Bottom-hole pressures are taken with an Amerada bomb.

In the west segment where there is only one zone the pressure drop has declined 57 lb. to the present pressure of 1193 lb. per sq. inch. In the east segment, the pressure in the upper zone has dropped only 27 lb. to a present pressure of 1038 lb. per sq. inch. The pressure in the lower zone, which has been drilled up faster, has dropped only 50 lb. to a present pressure of 1211 lb. per sq. inch. All pressures are corrected to 2600 ft. subsea datum.

The average depth of pumping wells in Quiriquire is about 2800 feet. The average production from these wells is 116 bbl. of oil per day, 40 percent of which is obtained by agitated flow. On

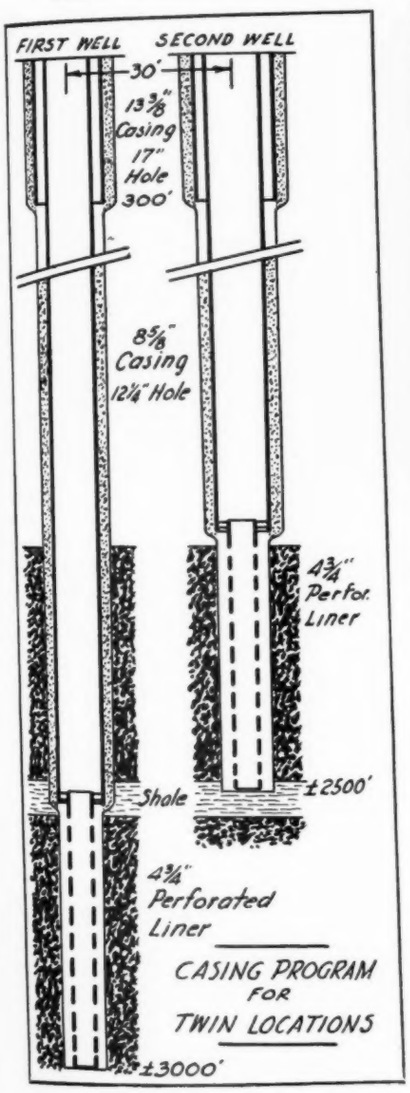
The electrical dehydration plant at Quiriquire with two units now in service

Wells on the pump generally are pumped with individual units in the Quiriquire field

the individual pumping units used for producing the wells, 15-hp. motors are employed at the present time but plans are to use 25-hp. in the future.

Cut oil is treated by electrical dehydration at a station now equipped with two units. These units are rated at 1500 bbl. each at 160 deg. fahr. but actually 4000 bbl. of oil is passing through them. The oil has a gravity of 16 deg. A.P.I. and is heated to 170 deg. fahrenheit. The oil into the plant is cut about seven percent and comes out 0.9 percent. This percentage could

Fig. 2. Drilling and casing procedure for twin locations



A gasoline engine-driven pump station, Quiriquire field

be reduced still further if the operation were not so crowded; so another unit will be installed.

Current for the operation is supplied by a Diesel-electric generator and is 220-volt d.c. in and 16,500-volt out at each transformer. The electrode setting is 8½ in. from top to center electrode and four in. from center to bottom electrode. The upper field is 33,000-volt and the lower field is 16,500-volt.

The oil produced from the west segment is of 14 deg. gravity A.P.I. and from the east segment 19 deg. A.P.I. The viscosity of the latter is extremely low for that heavy an oil and this facilitates separation of the gas and oil. Gathering stations are placed at convenient points in the field and usually are at an elevation below that of the wells flowing into them.

Flow from the wells is into separators elevated above the tanks and at each gathering station a manifold system provides flexibility of operation as can be seen in an accompanying photograph. The largest station takes the production from 23 wells and handles 40,000 bbl. of oil a day.

Pump stations at the gathering plants deliver oil directly into the main lines running from the field to Caripito. The input pressure is approxi-

The ten units at this compressor plant have a capacity of 7000 M. cu. feet

mately 500 lb. per sq. in. and the discharge at Caripito up to 150 lb. per sq. inch.

Repressuring operations have been carried on in this field since 1932. Gas from the separators is carried to a compressor plant that now has ten 8 by 5½ by 20 engines. The daily capacity of the plant is 7,000,000 cu. ft. with an intake pressure of 53 lb. and a discharge pressure of 1100 lb. per sq. inch. Four more engines will be added to the plant to make it a 14-unit station.

Up to the first of this year, 2,256,000 M cu. ft. of gas has been put back into the one zone in the west segment for repressuring. During the same time, 3,632,000 M cu. ft. of gas has gone into the upper zone in the east segment of the field, the lower zone not yet having been repressured. It is believed that this has maintained pressures in the field to some extent besides providing other production advantages.

In the repressuring operations, two wells are used. The input wells can be changed around when it is found to be desirable and in some instances after such wells have been put back on oil production they produce very well. The injection pressure at the intake wells, which are selected with care, is 950 lb. per sq. inch.

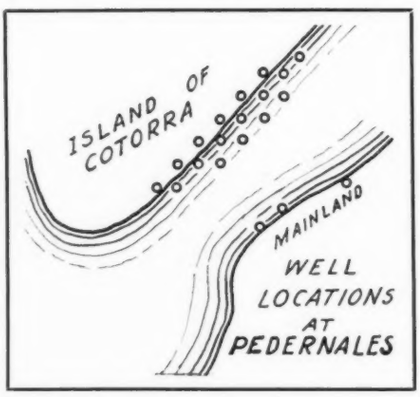
Pedernales

Development in this field is along the shore of the Island of Cotorra — Some wells are being drilled on water locations, others are water-and-land operations

THE wells at Pedernales are close by the Gulf of Paria along the most northerly branch of Orinoco River—one of the many branches that form the immense delta of that river. The general location is shown in Fig. 1, of article entitled "Eastern Venezuela —An Area with Both a Present and a Future," and the details of well locations in Fig. 1, this article. Only four of the wells are producing but two drilling rigs are in operation. The present daily production is about 2000 bbl. of oil of 19 deg. gravity A.P.I. and comes from the Cruse formations, which form the oil horizon in Trinidad.[1] The depth from which production is obtained at Pedernales is approximately 5000 ft., which is somewhat greater than at Trinidad.

As shown in Fig. 1, the course of development is along the shore of the Island of Cotorra. Some of the wells are being drilled on water locations; others are water-and-land operations. On the mainland, oil of low gravity is being produced and used for fuel.

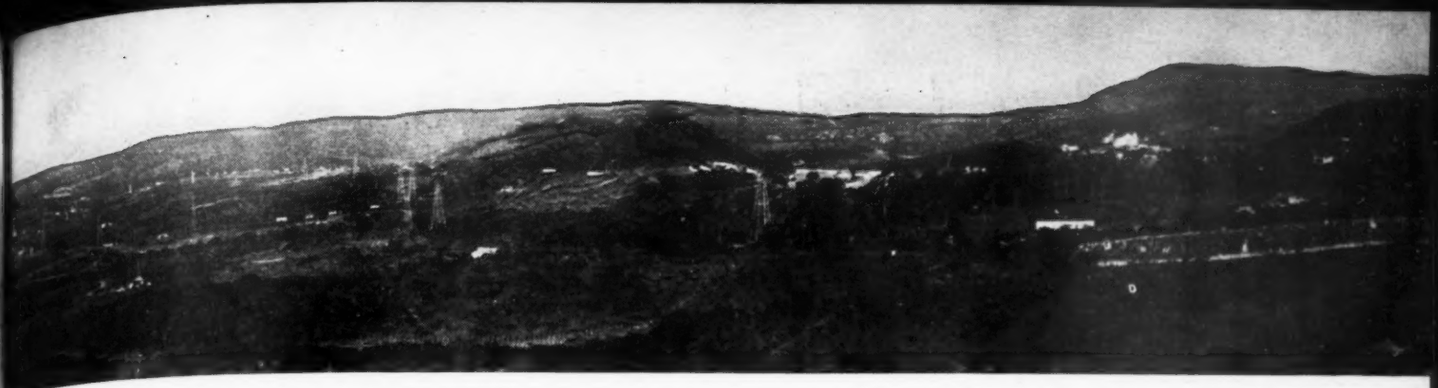
Fig. 1



Wells are completed at an average depth of about 5000 ft., 18½-in. casing being cemented at 200 ft., 13¾-in. at 1200 ft., and a 9⅝-in. water string at the top of the productive zone. The liner, however, is only 4¾-inch. Core samples are sent to Caripito for laboratory analysis.

Oil is exported on lake-type tankers of 14,000-bbl. capacity from a terminal called La Brea. These ships serve as shuttle tankers and carry the oil to Guiria where it is transferred to the larger boats. There is little storage at La Brea at the present time but more tanks will be erected there as soon as possible.

[1] See article "Trinidad Development Offers Interesting Prospects."

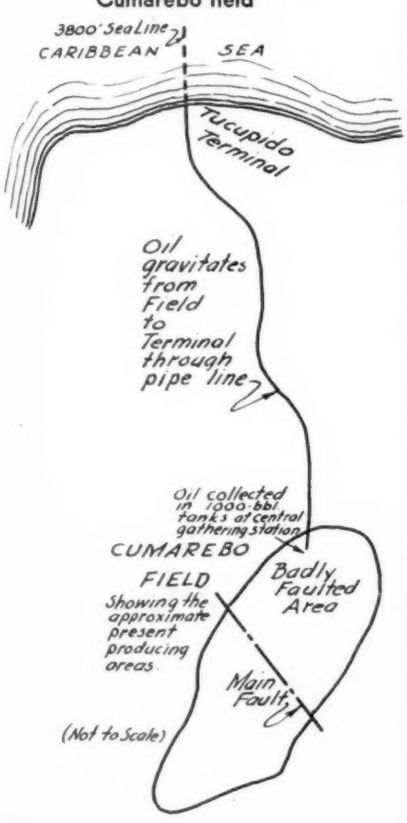


General view of Cumarebo field. Standard Oil Company of Venezuela camp is in left background. The field extends over most of the area shown and off to the left. Cumarebo El Pueblo is seen right of center; its cemetery on extreme right.

Cumarebo..Venezuela's Lightest Oil Field

LYING about four miles inland from the Caribbean Sea just east of the Peninsula of Paraguana, the Cumarebo field covers about 500 acres. It is operated by the Standard Oil Company of Venezuela and is in wireless communication with the company's main office at Caripito. The structure is a faulted anticline, a main fault dividing the productive area into northeast and southeast segments. The oil is of high gravity and averages more than 50 deg. A.P.I. for the entire field at the present time. Production is about 7000 bbl. of oil per day from 40 wells, only five of which are on the pump. Two drilling rigs are running with crews composed entirely of Venezuelans operating under the supervision of an American tool pusher.

Diagrammatic sketch of the Cumarebo field


3800' Sea Line
CARIBBEAN SEA
Tucupido Terminal
Oil gravitates from Field to Terminal through pipe line
Oil collected in 1000-bbl tanks at central gathering station
CUMAREBO FIELD
Showing the approximate present producing areas
Badly Faulted Area
Main Fault
(Not to Scale)

Production is obtained from three sands in a zone called the Damsite and from seven sands in a lower zone known as the Socorro. The No. 4 sand in the Socorro is producing about 40 percent of the oil; the lowest sand in the Socorro is a gas sand.

The northeast segment is badly faulted and here are found the shallow pay sands in the Damsite zone. Wells in the Damsite range in depth from 550 to 750 feet. The average depth of wells in Socorro No. 4 in the southwest segment is 1200 feet. The casing program for these wells includes 13⅜-in. surface pipe, which is set at depths determined by the terrain but never greater than 200 feet. The water string is 8⅝-in. and in this is run a 6⅝-in. liner. Production is through 2-in. tubing and some of the wells are on a ⅛-in. choke.

Production is controlled by bottomhole pressure and gas/oil ratio. The gas/oil ratio averages about 540 cu. ft./bbl. and when it gets high in any well, that well is choked back. Bottomhole, tubing, and casing pressures are all watched carefully and production regulated according to the data obtained. Every effort is being made to produce the field with maximum efficiency and to obtain the greatest ultimate yield from all sands.

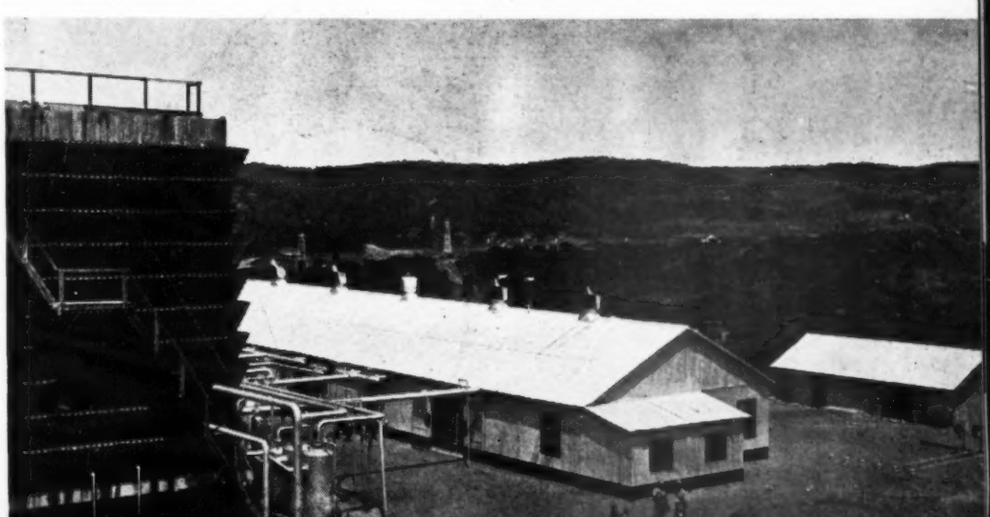
Very high pressures for the shallow depths drilled are encountered in the field. The original pressure in the Socorro No. 4 sand is estimated to have been 625 lb. per sq. in. at 800-ft. datum. This pressure is now only 50 lb. lower, probably the result of returning gas to the sand to maintain pressure.

Gas for repressuring the No. 4 Socorro sand is piped to an input well on the top of the structure from a compressor plant. More gas is put into the sand than is taken out, 1700 M cu. ft. per day of gas goes in and only 700 M cu. ft. is taken out. This excess of gas is produced with the oil from other sands.

The Cumarebo field is about four kilometers south of the sea coast and lies at a considerable elevation above the sea, there being a general slope upward to the south from the shore line. Taking advantage of the topography, a pipe line was laid from a central gathering station at the field to a terminal on the Caribbean sea a short distance east of Puerto Cumarebo. Oil from the field gravitates from the gathering station to the terminal called Tucupido, and from there is loaded in deep-sea tankers, which receive the oil through a submarine pipe line that extends more than a kilometer from shore.

A main gathering line extends the length of the field and conveys the oil from the producing wells to the central gathering station. As the oil gravitates, pumping is not necessary to deliver it to the gathering station. A battery of ten 1000-bbl. tanks at the central gathering station takes care of field storage. All oil passes through separators for the removal of gas.

Compressor station at Cumarebo



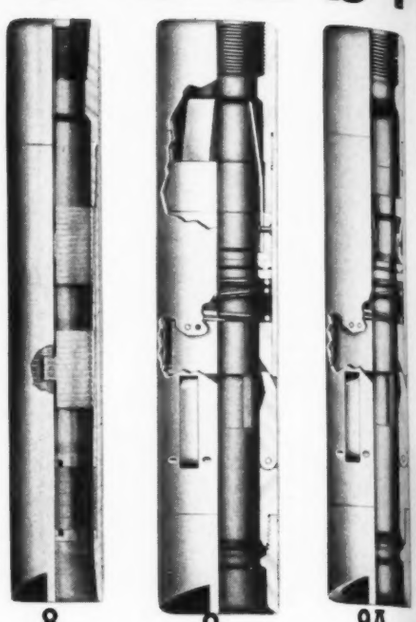
BAASH-ROSS

SAFE, MODERN OIL TOOLS!

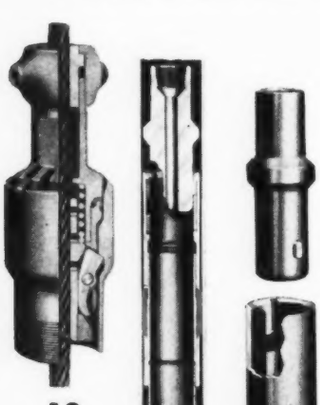
8 The Packing Casing Bowl effects a permanent connection between new casing and the casing remaining in the well after a defective section has been removed.

9-9A The External Drill Pipe Cutter is run on washover pipe. The cut is quickly made by rotating the fishing string, and the cut-off pipe is retained in the washover pipe by the overshot springs while being withdrawn from the hole. Interchangeable slip assembly (shown in 9A) adapts this cutter for cutting external flush joint drill pipe.

10 This non-sparking oil saver closes the well and allows all of the fluid to be expelled through the flow lines while the well is being swabbed or bailed. Automatically opens, closes and seals.



8 9 9A



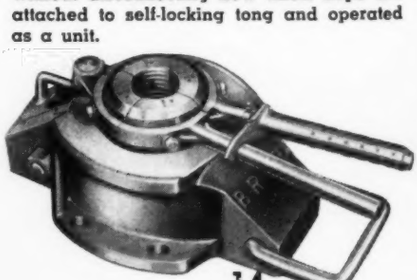
10 11 12

11 Packing type Adapter is attached to the top of the liner and permanently seals between the liner and casing. Easy to set and release.

12 The Baash-Ross Liner Setter and Adapter insure safety in running and removing liners of any length. (See Numbers 11 and 13 also.)

13 This packing-type Liner Hanger effects a permanent seal between the casing and the liner and supports the longest liner with safety. Releases easily when liner is to be pulled; can be used over and over again.

14 Open End Tubing Spider is installed without disconnecting flow lines. Slips are attached to self-locking tong and operated as a unit.



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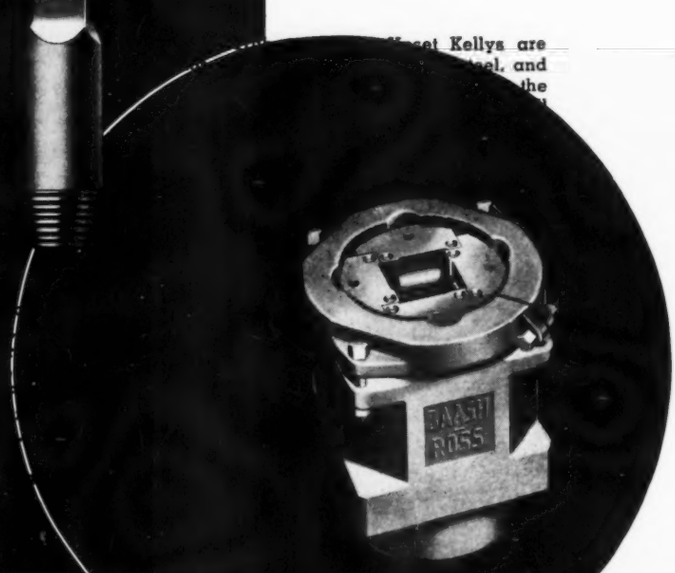
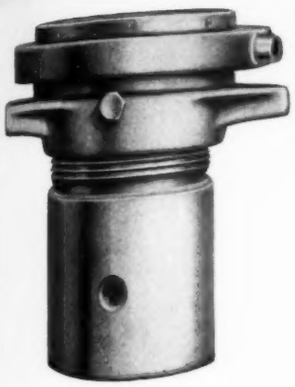


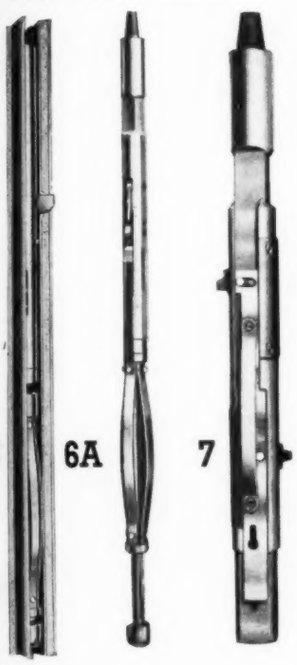
17 The full length rollers of the Roller Kelly Bushing insure even, controlled feed of kelly through rotary without binding when coring, drilling and fishing. Maximum driving surface with minimum friction.

WHEREVER YOUR WELL MAY BE—



1

This Baash-Ross Blowout Preventer is a positive means of packing off between drill pipe and casing to control pressure and blowouts. It should be on every drilling well. Always in working condition.



6 **6A** **7**

2 The force of the blow delivered by this Improved Kammerdiner Rotary Jar is governed by the torque created in the fishing string. Automatically tripped by a straight pull; automatically re-set by lowering the drill pipe.

3 This Internal Casing Cutter is known and used in all of the oil fields in the world. Made in all sizes to cut casing, tubing or internal flush joint drill pipe.

4 The extra long, flat-backed slips of the Rotary Releasing Spear are solidly backed up by the three-step surface of the body. Slips are uniformly set and positively released by rotation of the fishing string. Withstands long, continuous jarring without damage.

5 The Autolock Safety Joint permits rotation in either direction required for the operation of fishing tools. Spring loaded safety collar prevents lower half from rotating off when going in or coming out of hole. Easily released if tools become stuck in the hole.

6-6A The Long Knife Perforator is positive in action and penetrates two strings of casing with cement between them. Punches any desired number of holes. Made for Rotary and Cable Tools.

7 The Star-Wheel Perforator punches evenly spaced holes through one string of casing. Made for both Rotary and Cable Tools. Unsurpassed for fast operation.

2 **3** **4** **5**

REFER TO THE BAASH-ROSS SECTION IN YOUR 1937 COMPOSITE CATALOG . . . PAGE 151 TO PAGE 186 . . . OR WRITE FOR THE BAASH-ROSS CATALOG . . . WHICH WILL BE SENT PROMPTLY ON REQUEST

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General view of the Lago Oil and Transport Company's refinery at Aruba

The Refineries at Aruba and Curacao

On the two islands, which lie just off the mainland of Venezuela, are situated three refineries, belonging to Standard Oil Company and Shell interests

ALTHOUGH the discovery of new oil-producing areas of any considerable extent in Venezuela will be accompanied by the erection of refining facilities on the Venezuelan mainland, most of the oil produced by this country is now being exported in its crude state. That produced by the Gulf interests is shipped to the company's terminal at Las Piedros on the peninsula of Paraguana and from there is transported to other points of refining. The bulk of the oil produced by the Standard companies and by the Shell subsidiaries goes to the islands of Aruba and Curacao where refineries have been erected.

Venezuela's own demands for motor fuel and other refined products are met by plants situated at or near the various oil fields. A number of these plants provide only for skimming and many merely supply naphtha and cuts of gas oil. Natural gasoline is made in quantities greater than the demand for blending and more fuel oil than can be used is produced; therefore, in addition to shipping crude oil to the island refineries from Venezuela, appreciable quantities of crude gasoline and kerosene, gas oil, and fuel oil also are sent there.

There are three refineries on the two islands of Aruba and Curacao. These islands are a part of the Netherlands West Indies and lie just off the mainland of Venezuela, as shown on the accompanying map. On Curacao is the large refinery of the Curacaosche Petroleum Industrie Maatschappij, a Shell plant to which most of the oil from Shell operations in Venezuela is sent. Another Shell refinery, that of Arend Petroleum Maatschappij, is situated on the northern end of the island of Aruba. On Aruba also is the large refinery of the Lago Oil and Transport Company, a Standard of New Jersey subsidiary, which takes the bulk of oil produced by the Standard companies in Venezuela. The amount of raw material imported into these two islands during the last two years is shown in Table I, which, however, does not include 707,000 bbl. of crude from Colombia received in 1935.

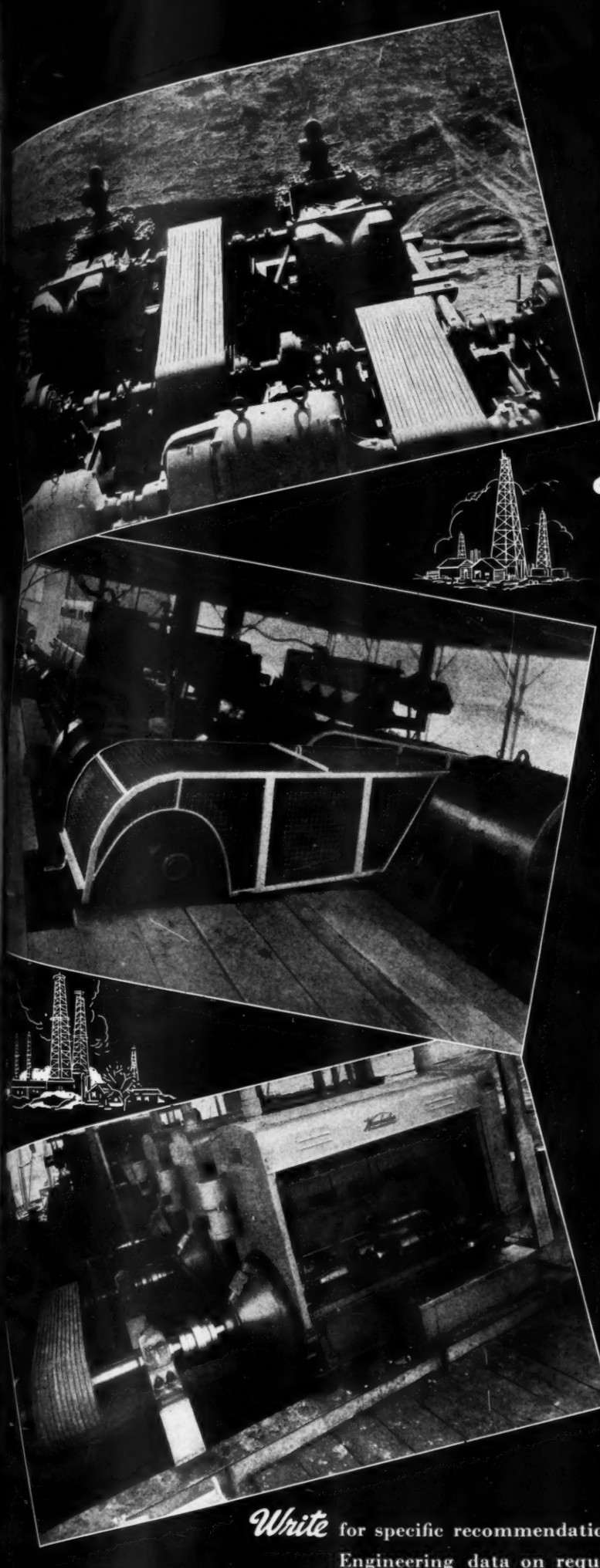
Products refined on the islands are exported to countries throughout the world. The volume of the various products is indicated by Table 2 and it will be noted that the quantity of fuel oil is large. Gasoline is an important product and the destinations of gasoline and fuel oil in Table 3 show the vast territory served by the Aruba and Curacao refineries.

The refinery on the island of Curacao is at Emmastad near the world-renowned port of Willemstad and was the first to be placed in operation. It has been enlarged several times and modernized, having some of the latest equipment, including additional cracking and naphtha reforming units with capacities of nearly 9000 bbl. per day each. The latest reports place the total refining capacity of the plant at more than 170,000 bbl. daily.

The Lago Refinery at Aruba

The Aruba refinery of the Lago Oil and Transport Company has a normal operating capacity of approximately 225,000 bbl. daily, but, due to its flexibility, a daily throughput in excess of 228,000 bbl. has been obtained for a 7-day period. The plant is a complete refinery, its principal products at the present time consisting of motor naphtha, kerosene, gas oil, lubricating distillates, Diesel oil, bunker fuel oil, and reduced crudes for special purposes. Most of these products are produced in several different grades to meet varying market requirements.

Over tanker lanes to Aruba, indicated on the accompanying map, the Lago refinery procures the bulk of its oil from the Lake Maracaibo fields of the Lago Petroleum Corporation and from the Standard Oil Company of Venezuela properties in Eastern Venezuela and at Cumarebo. Oil is transported from the Lake fields by 20



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Write for specific recommendations.
Engineering data on request.

TWIN DISC CLUTCHES

TABLE 1
Imports of Petroleum into Netherlands West Indies. (In bbl. of 42 U.S. gal.)

	1935	1936
Crude oil	120,695,000	125,009,000
Crude gasoline	1,180,000	173,000
Crude kerosene	.....	1,070,000
Gas oil	893,000	1,034,000
Fuel oil	4,847,000	4,458,000
Totals	127,615,000	131,744,000

shallow-draft tankers. From the Quiriquire and Pedernales fields usually the oil is loaded on tankers at Guiria, either from the tank farm there or from shuttle tankers that bring the Quiriquire oil from the Caripito terminal on the San Juan River and the Pedernales oil from La Brea terminal on the Gulf of Paria. Most of the refined products from the plant are shipped directly to markets outside the United States to destinations throughout the world.

Of outstanding interest is the extensive application of electricity in the Aruba refinery. This refinery is completely electrified, and probably is the most completely electrified oil refinery in the world. All machinery, pumps, and other equipment except standby fire-fighting apparatus are operated solely by electricity. Current is supplied by a steam-turbine electric generating plant, which has a capacity of approximately 27,500 kva. and handles daily peak loads that run as high as 24,000 kva. An additional 10,000 kva. generating capacity, however, now is being installed to take care of future demands that may be put upon the plant by increased loads.

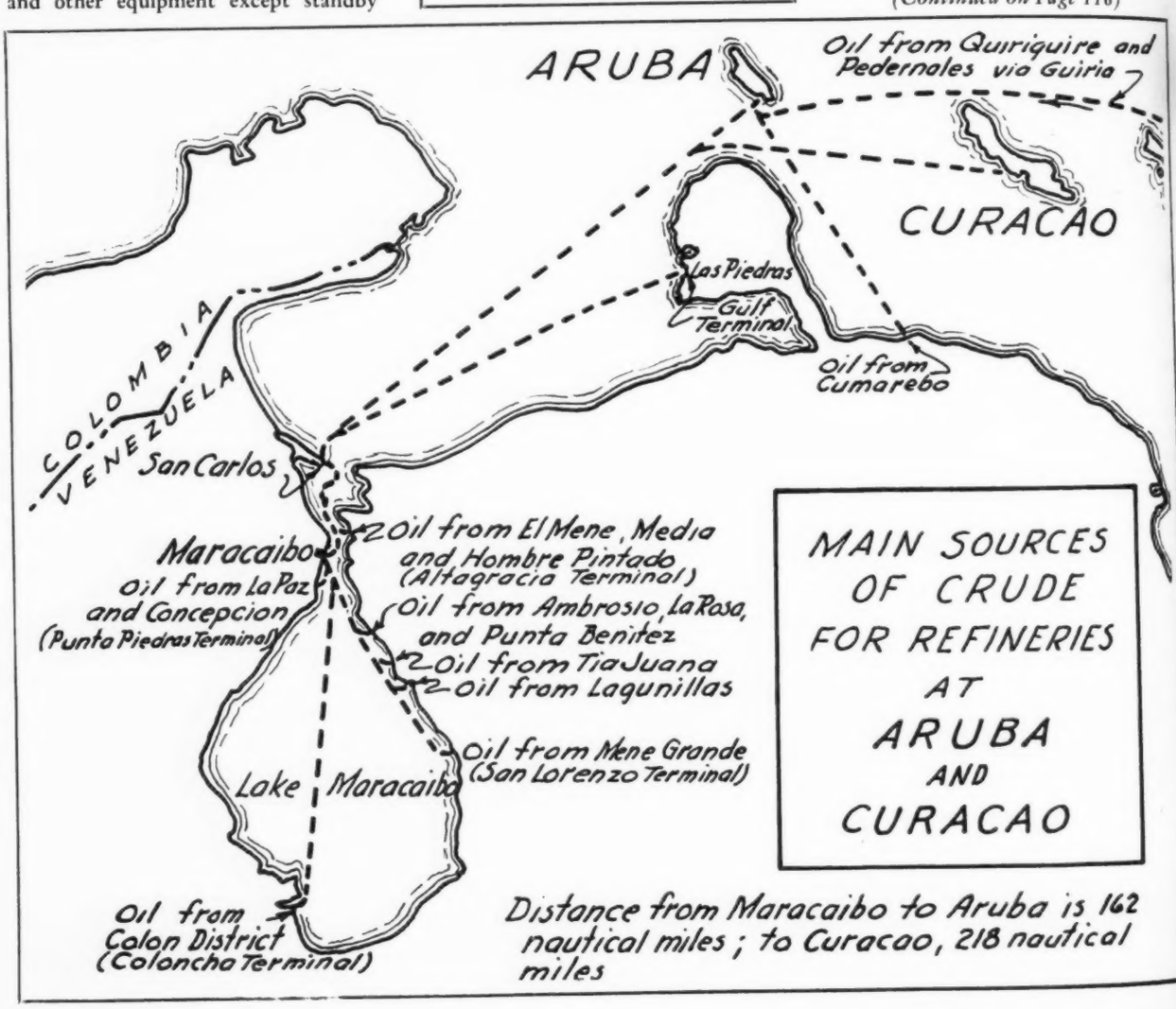
There is practically no fresh water to be found on Aruba and this condition naturally was a governing factor in the design of the plant. Unlike mainland operations where, although nearby fresh water is scarce, it can be made available by piping from a plant constructed at a distant source of supply, the water for any purpose has to be imported by boat or distilled on the island. For this reason all drinking water is imported from the United States and about 2000 bbl. daily is brought in for that purpose alone. Water used for process requirements, boiler feed, and other operating needs, however, is distilled from sea water. Two evaporation plants having a total capacity of 11,000 bbl. daily therefore have been installed and produce the necessary fresh water for plant and other operations.

The problem of food also is one that requires continuous attention. The island is rather sparse of vegetation and wind-blown and produces very little food. What foodstuffs that can be produced are unsuitable for the foreign employees and their families. As a result, all food for the foreign staff and substantially all food required for native employees and their families has to be imported. Most of this comes from the United States and is shipped on special tankers equipped with refrigerating facilities.

(Continued on Page 116)

TABLE 2
Exports from Netherlands West Indies (In bbl. of 42 U.S. gal.)

	1935	1936
Crude oil	6,409,000	8,996,000
Gasoline	26,984,000	30,455,000
Kerosene	3,793,000	3,850,000
Lube oil	1,376,000	1,983,000
Gas oil	7,084,000	8,323,000
Diesel oil	5,750,000	9,108,000
Fuel oil	68,170,000	74,848,000
Totals	119,566,000	137,563,000


ARUBA
Oil from Quiriquire and Pedernales via Guiria
CURACAO
Las Piedras
Gulf Terminal
Oil from Cumarebo
COLOMBIA
VENEZUELA
San Carlos
Maracaibo
Oil from La Paz and Concepcion (Punta Piedras Terminal)
Oil from El Mene, Media and Hombre Pintado (Altagracia Terminal)
Oil from Ambrosio, La Rosa, and Punta Benitez
Oil from Tia Juana
Oil from Lagunillas
Oil from Mene Grande (San Lorenzo Terminal)
Lake Maracaibo
Oil from Colon District (Coloncho Terminal)
MAIN SOURCES OF CRUDE FOR REFINERIES AT ARUBA AND CURACAO
Distance from Maracaibo to Aruba is 162 nautical miles; to Curacao, 218 nautical miles

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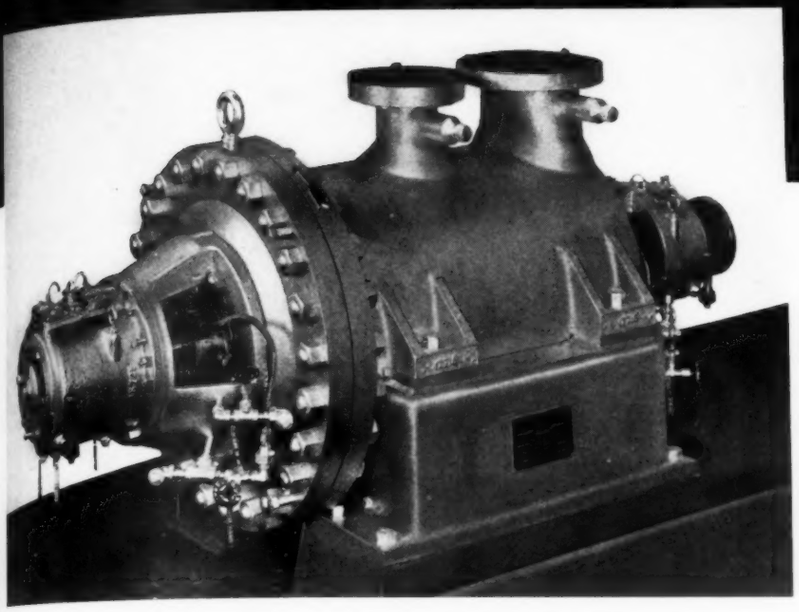
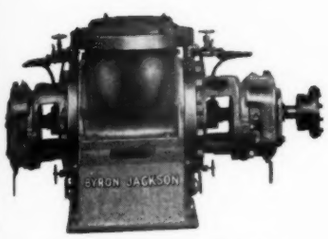
BYRON JACKSON PUMPS



DOUBLE CASE HOT OIL CHARGING PUMPS

The horizontally-split inner case permits assembly of complete rotating element IN THE SHOP, as a separate unit. Other features include: Both stuffing boxes under low pressure—Minimum number of parts—No diffusion Vanes—Capacities range from 2,500 to 40,000 barrels daily at pressures up to 2,100 pounds per square inch.



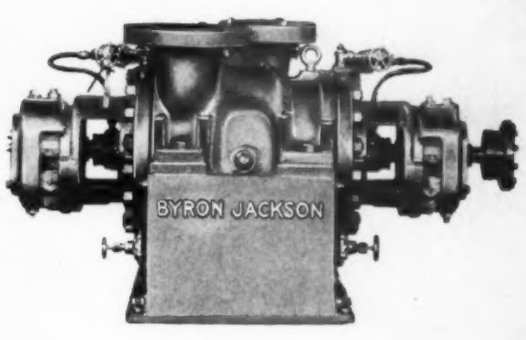
BYRON JACKSON SINGLE STAGE DOUBLE SUCTION PUMPS

Modern features include: Center support under nozzles eliminates pipe strains with resultant misalignment at high temperatures — Case and cover sealed by two circular gaskets in recessed seats, only one of which is broken to dismantle pump — Nozzles cast integral with case for disassembly without disturbing piping — Vertical nozzle arrangement simplifies piping and eliminates vapor binding in the suction — Two stuffing boxes at suction pressure — Negligible bearing loads — Field of application, 800 to 3,000 G.P.M. at temperatures up to 800 degrees F., against heads of 250 to 800 feet.

A single suction type, designed to overcome previous objections to single suction construction, will deliver from 15 to 800 G.P.M., at temperatures up to 800 degrees F., against heads from 75 to 400 feet.

VC 2-STAGE HOT OIL PUMPS

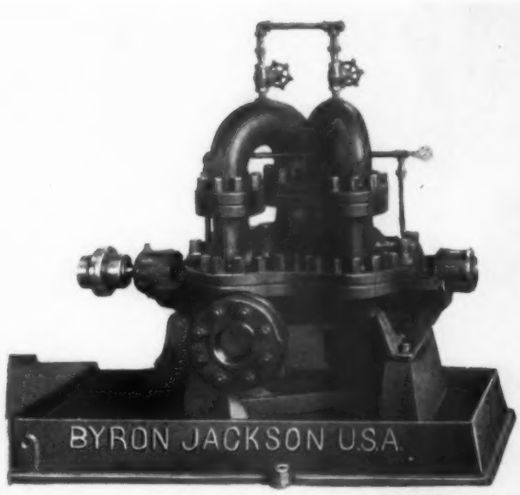
The vertically-split case, with circular gasket, is one of numerous safety features of BYRON JACKSON VC PUMPS that appeal to modern refinery operators. They are furnished in different sizes to handle from 20 to 4,000 G.P.M. of oil, at temperatures from 300 to 850 degrees F., on differential pressures up to 350 pounds per square inch.



O. L. MULTIPLEX PUMPS

Although designated as "O.L." (Oil Line Pumps), the Byron Jackson MULTIPLEX has many applications other than for pipe line service. They are well suited to cold and warm oil charging service. Increased efficiency is due to the long external cross-overs which provide good hydraulic lines between stages. These pumps, of extremely rugged construction, are made in a wide range of sizes and stage combinations to meet every requirement.

Your request for specifications will receive prompt and careful attention.



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CENTRIFUGAL PUMPS FOR EVERY SERVICE

(Continued from Page 113)

At the time operations were begun no housing facilities, sanitary provisions, schools, hospitals, or other requirements attendant upon the construction and operations of a refinery, were available. These naturally have been provided by the company for imported North American and European employees and their families and to an increasing extent for native employees.

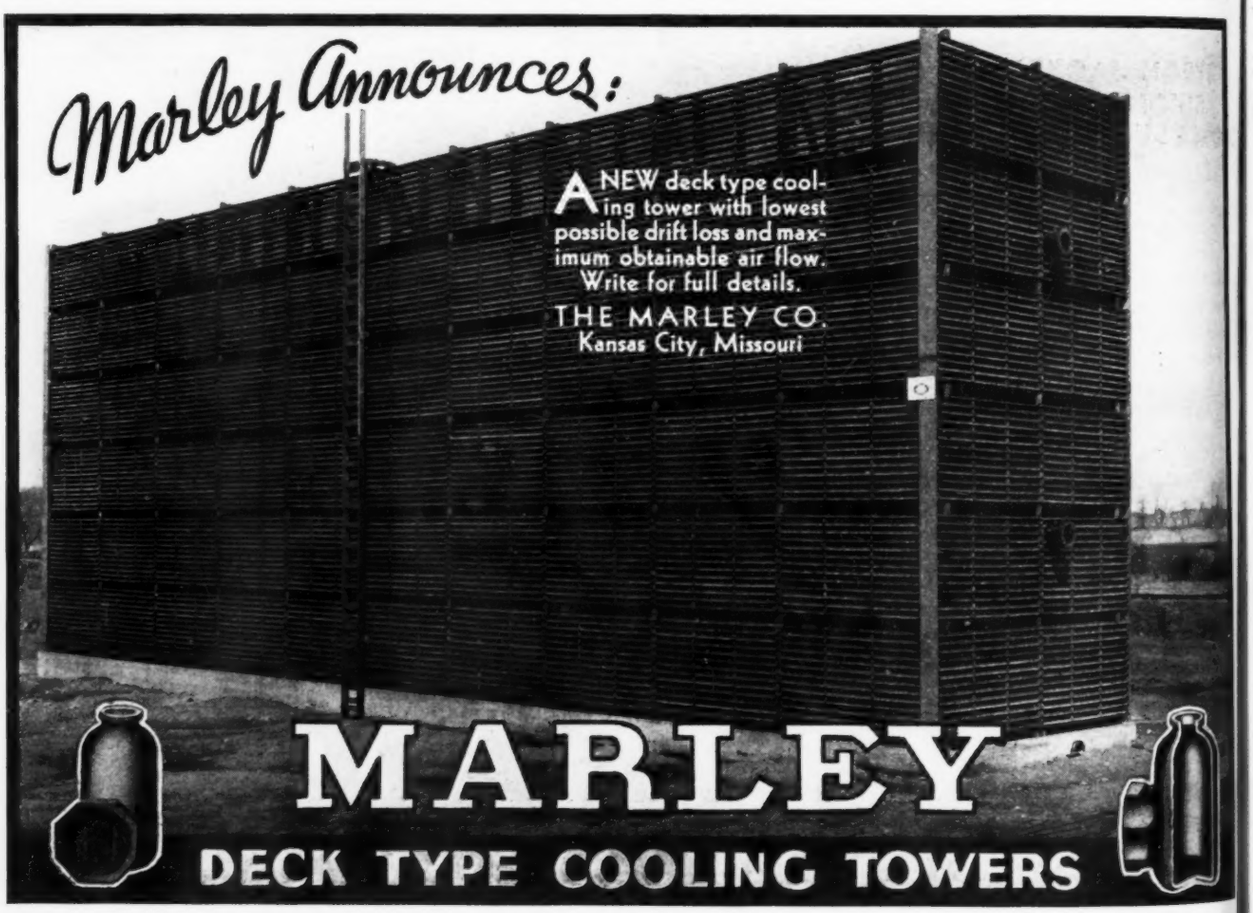
Originally there were no skilled or semi-skilled employees to be found in Aruba or the islands in the Caribbean area and such labor as was available could be utilized only to perform the most simple tasks. An intensive training program has produced a large number of skilled native employees, many of whom do as good work and at about as high a production level as would be expected from skilled mechanics any place in North America or Europe.

The total number of employees at the Lago Oil and Transport Company's refinery on the island of Aruba is approximately 2900. Of these, 600 have been brought in from North America and Europe and hold mainly supervisory and technical positions. The other 2300 men mostly are from the Netherlands West Indies and a few from the adjacent Caribbean area.

TABLE 3

Exports of Gasoline and Fuel Oil from Netherlands West Indies (In bbl. of 42 U.S. gal.)

Destination	Gasoline		Fuel Oil	
	1935	1936	1935	1936
Belgium	426,000	1,423,000	77,000	151,000
Denmark	68,000			
Finland	138,000	506,000		
France	216,000	123,000	681,000	957,000
Germany	205,000	762,000	3,507,000	4,653,000
Irish Free State	62,000	443,000		
Italy	448,000	201,000	1,976,000	1,435,000
Netherlands	3,368,000	4,140,000	1,148,000	1,387,000
Norway	272,000	468,000	99,000	303,000
Portugal	210,000	474,000	1,424,000	1,238,000
Sweden	715,000	1,571,000	49,000	21,000
United Kingdom	18,611,000	18,270,000	8,598,000	8,420,000
Canal Zone	13,000		2,028,000	360,000
Dominican Republic	16,000	18,000	83,000	89,000
Haiti	5,000	8,000		
United States	108,000	359,000	17,771,000	17,914,000
Argentina	236,000	35,000	6,042,000	6,235,000
Brazil	683,000	964,000	1,988,000	3,332,000
Union of South Africa	70,000	141,000	656,000	1,566,000
Egypt	170,000		1,695,000	2,064,000
French West Africa	101,000	330,000		
Gibraltar			687,000	1,511,000
Malta			97,000	203,000
Honduras			633,000	532,000
Panama			132,000	1,792,000
British West Indies			452,000	796,000
Cuba			2,399,000	2,587,000
Virgin Islands			315,000	177,000
Puerto Rico			995,000	1,210,000
Ecuador			44,000	47,000
Uruguay			945,000	1,644,000
Palestine			45,000	
Turkey (Asiatic)			43,000	1,000
Algeria and Tunisia			1,545,000	330,000
Other French Africa			350,000	760,000
Portg. Africa and Islands			116,000	
Canary Islands			533,000	361,000
Spanish Africa			563,000	205,000
Antartica			1,505,000	1,788,000
Whale Grounds			261,000	
Ship Bunker			5,765,000	7,009,000
The Lizard for orders			225,000	
South Georgia			184,000	
Others	843,000	219,000	2,501,000	3,771,000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Venezuela Inaugurates Geological Congress

Purpose is to disseminate geological data and thus aid the further discovery and development of petroleum and other natural resources in Venezuela

REALIZING the need for the dissemination of geological data to aid the further discovery and development of petroleum and other natural resources in Venezuela, annual meetings have been arranged for that purpose by the Ministerio de Fomento and will be held at various interesting localities in the country during the coming years.

The First Venezuelan Geological Congress was organized by the Servicio Técnico de Minería y Geología, a department of the Ministerio de Fomento, and was held under the auspices of that Ministry at Caracas from February 15 to 22 of this year.

The inaugural session was honored by the presence of the President of the Republic, General E. López Contreras, who addressed the members of the Congress, emphasizing the importance of the meeting for the advancement of the knowledge of Venezuelan geology, and by the Minister of Fomento, Dr. Néstor Luis Pérez, Honorary President of the Congress, who gave the official welcome.

Dr. Guillermo Zuloaga, geologist of the Servicio, was appointed general secretary for the Congress and during the first session Pedro I. Aguerrevere, geologist for the Ministry of Public Works, was elected chairman.

The meetings were attended by 41 geologists and petroleum and mining engineers engaged in various geological and mining operations in the country. The Government Geological Survey and all the oil companies working in Venezuela were represented by members of their geological staffs, and the Island of Trinidad also sent a distinguished delegation. During their stay in Caracas, all the geologists attending the Congress were official guests of the Government.

The general subject of the Congress was the stratigraphy of Venezuela in its broadest sense, and in all 15 papers were read, covering Venezuelan stratigraphy from the Paleozoic to the Recent. In spite of the short time available for the preparation of papers, many of them covered their subject in considerable detail and very valuable discussions arose after their presentation.

The titles of the papers were the following:

"Notas Geológicas Relativas a la Parte Central de la Cordillera de la Costa," by S. Aguerrevere and Dr. G. Zuloaga.

"Contribución a la Geología del Sur-Oeste de los Andes de Venezuela," by Victor Oppenhein.

"Some Observations on Cretaceous and Pre-Cretaceous Beds in Western and Central Venezuela," by Dr. L. Kehrer.

"Synopsis of Formation of Western Part of Maracaibo Lake Basin," by H. Hedberg and L. C. Saas.

"Eocene of Bolívar Coastal Fields and Paleontology of Bolívar Coastal Fields," by N. W. Haas and R. G. Hubman.

"Saratigraphy of Mene Grande Area," by G. E. Tash.

"Geology of Some Area in the Vicinity of Mene de Buchivacoa," by G. N. Halse.

"Notas sobre la formación Punta Gavilán en la Región Oriental del Estado Falcón," by H. N. Suter.

"Geología General y Estratigrafía de la Región de Cumarebo, Estado Falcón," by Dr. C. Gonzalez de Juana.

"Comparison of Maracaibo and Maturín Sedimentary Basins," by Dr. C. Wiedenmayer.

"Stratigraphy of the Río Querecual Section of North Eastern Anzoátegui," by Hollis D. Hedberg.

"Geological Section in the Barinas Area," by A. N. Mackenzie.

"Los Grandes Mamíferos Fósiles de la Región de Barquisimeto," by H. Nectario María.

"Las Rocas Quaternarias de la Región del Proyectado Dique de Macarao," by Dr. W. Grenouillet.

At the end of the regular meetings a field trip was made under the guidance of Dr. L. Kehrer, geologist for the Shell companies in Venezuela, to the very interesting section from San Juan de los Morros to Ortiz in the State of Guárico. By virtue of Dr. Kehrer's broad experience in Venezuela and his excellent qualifications as a field man the delicate complications in structure and correlation were very ably presented and the trip thoroughly enjoyed by all delegates.

S. E. Aguerrevere and Dr. Guillermo Zuloaga pointed out in the field their conclusions regarding the origin of the metamorphic rocks of the Cordillera de la Costa and explained some views on its physiographic developments.

As a final sight-seeing trip, on Sunday, February 21st, all delegates were taken along the shores of Lake Valencia and on to Rancho Grande (1200 meters elevation), a hotel on the Cordillera de la Costa, where one enjoys a fine view of Lake Valencia and vicinity. The same day the party returned to Caracas.

On Monday the 22nd, the closing session was held in Caracas and plans for future meetings were discussed. It was decided to have the second Congress during the early part of 1938. San Cristóbal, capital of the State of Táchira, was selected because of the interesting geological sections in the vicinity.

At the end of the closing session G. W. Halse, chief geologist of the British Controlled Oilfield, Ltd., spoke in the name of all the delegates, thanking the Government for the fine opportunity that the Congress afforded to discuss Venezuelan geology and for the courtesies extended to them while guests of the Government.

All contributions to the Congress shall be published both in Spanish and in English in the *Boletín de Geología y Minería*, official publication of the Servicio Técnico de Minería y Geología.

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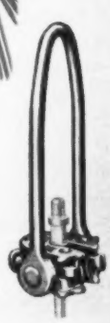

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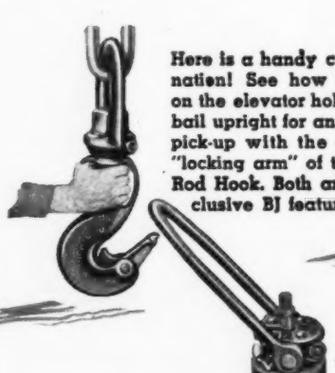

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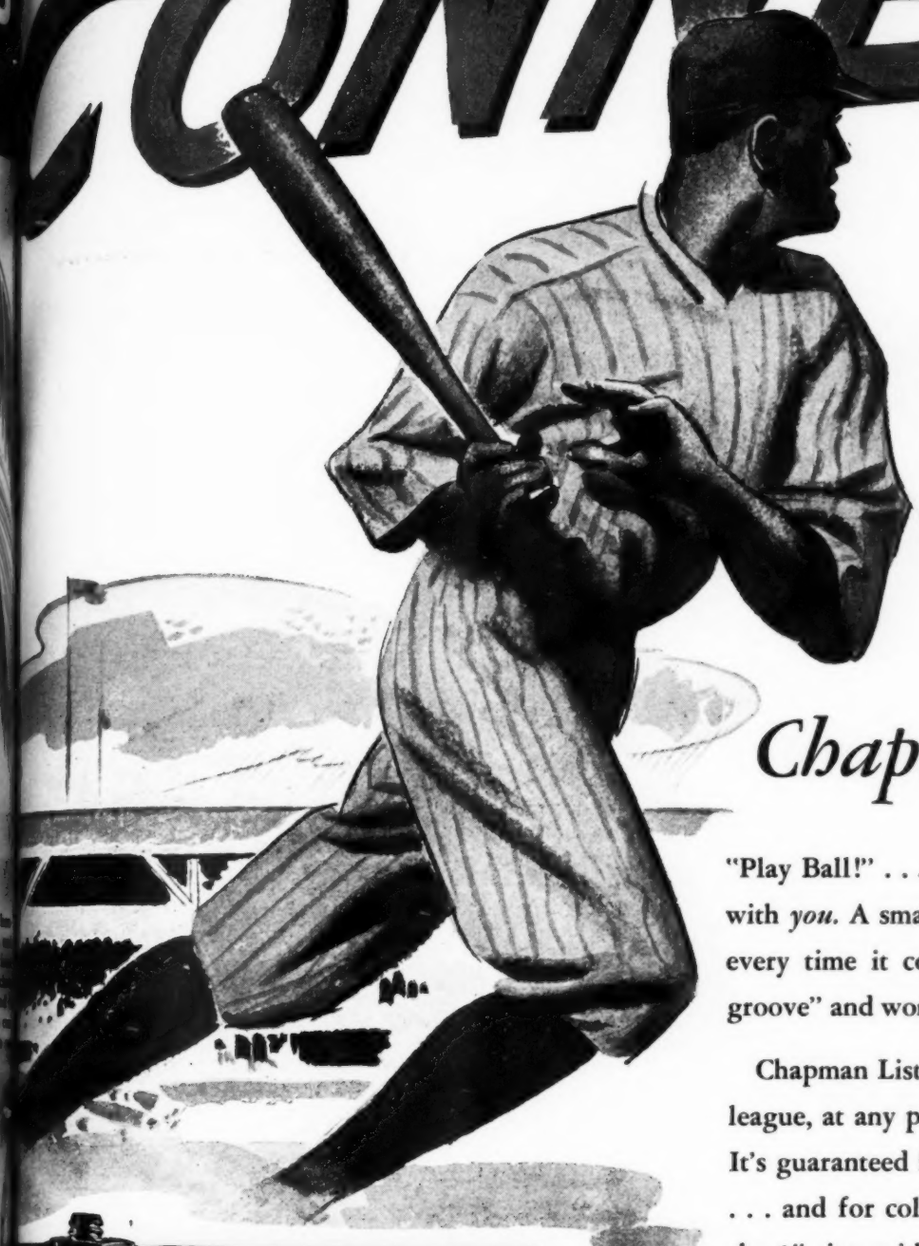

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Aerial view of the Rio Magdalena. Here can be seen the conditions under which the Andian pipe line had to be laid. Maintenance along this river for almost its entire length naturally is difficult. *(Photo reproduced through courtesy Scadta Airway System)*

Possibly no other country of northern South America offers as many natural obstacles to petroleum development as does Colombia

Petroleum Development in Colombia . . . Great Variety Difficulties Being Overcome

COLOMBIA probably offers more natural obstacles to petroleum development than any other of the northern oil-producing countries of South America. In the first place, the present oil supply comes from a location distant from any sea port and is difficult of access. To export the crude produced, a pipe line 537 kilometers long had to be constructed along a river valley that is covered with lakes and tributary streams, and is bordered by jungle growth along the greater portion of its route. Equipment for drilling, production, and refining operations has to be transported up this river on paddle-wheel steamboats. In the rainy season the river is full; but during the dry season boats frequently get hung up on shifting sand bars. The climate in the field is hot and humid all the time and camps and operations are surrounded by the ever-encroaching jungle.

In addition to the producing areas around El Centro, considerable development work is being done in the Barco Concession lying along the Venezuelan border. (See Fig. 1). Here are several probable structures. Only the one known as the Petrolea field, however, has been drilled with any definite results and the ten producing wells completed in that area now are shut in. In the northern part of the concession some wells have been drilled on the Rio de Oro structure but only one small producer has ever been reported. Wells drilled in this area have gone below

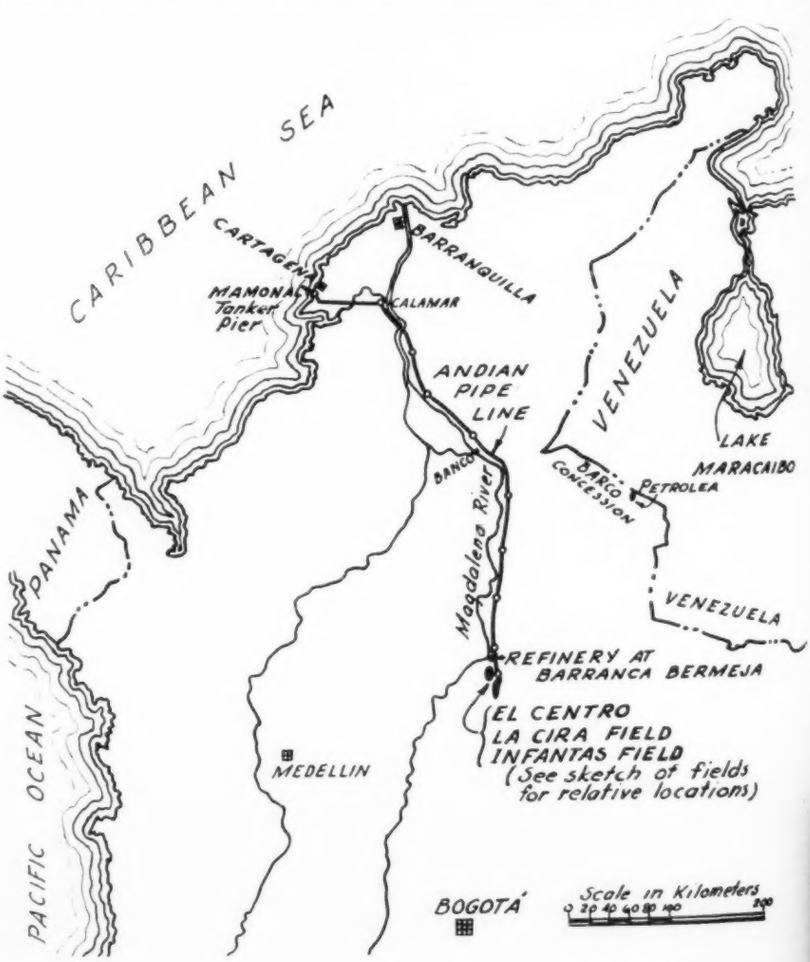

Fig. 1. The northern portion of Colombia where present oil production is obtained, showing general locations of producing fields, refinery, and pipe line to tidewater

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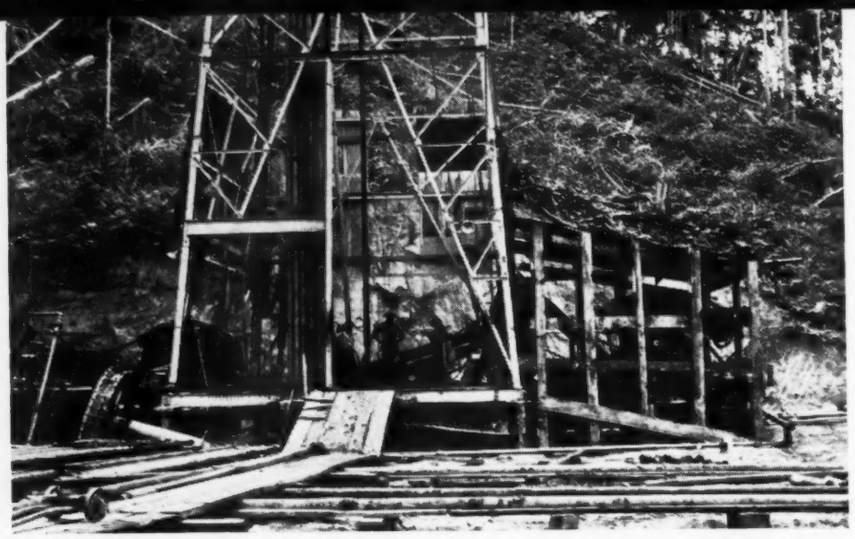
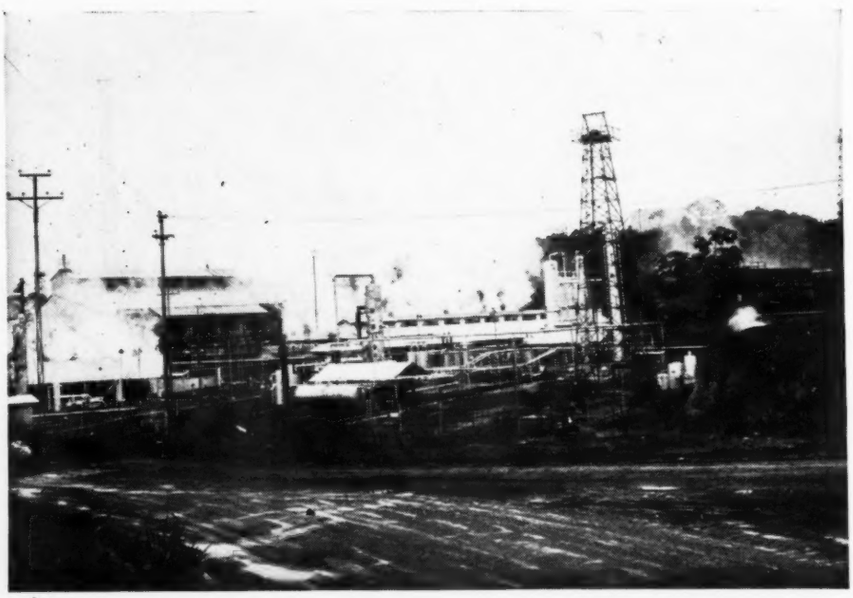


Close-up view of a drilling well in the La Cira field



Gasoline plants and power plant, El Centro

6000 ft., but those completed in Petrolea are all less than 2000 ft. in depth.

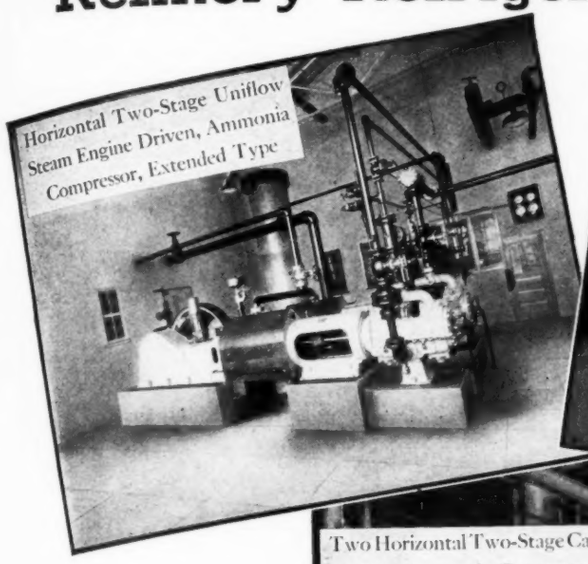
Transportation of equipment to the Barco operations is in itself a problem and is being done by water up the rivers from Lake Maracaibo. Access to the concession is either by this route or over the mountains from the Magdalena River Valley via highway, train, canoe, and mule. The unfriendly Indian tribe of Motilones adds to the hazard of operations and only recently an attack resulted in the death of a driller by infection from a flesh wound inflicted by an arrow. The problem of piping the oil, when developed in sufficient quantity, is probably the most serious, as a line must be laid on Colombian territory to a Colombian port. This means crossing a mountain range and building the line and pump station in dense jungle.

Geological exploration of any kind is most difficult in Colombia. Oil seepage has been the means of discovering the present production around El Centro and the shut-in production at Petrolea, but geophysical parties now are at work in several different parts of the country. A number of structures already have been mapped and exploration work undoubtedly will be on a more extensive scale than in the past. A few wildcat wells now are being drilled, several companies being interested not only in those wells but also in structures that show possibilities.

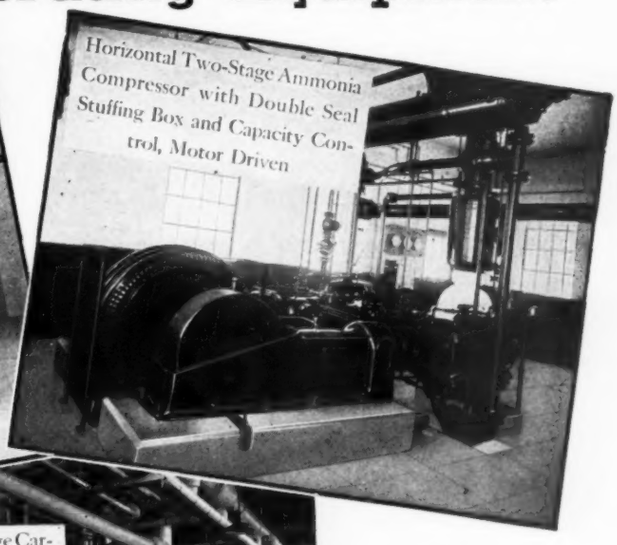
Among the wildcat tests being drilled is one by the Socony-Vacuum Oil Company approximately 60 kilometers north of El Centro. The area being tested is known as Aguas Clara and fuel oil is being taken from one well already drilled. South of El Centro about 40 kilometers the Tropical Oil Company is drilling a wildcat at Lisama. Geological and geophysical parties of other companies are exploring in the upper Magdalena Valley. Oil seepages are reported in Colombia near the Peru-Ecuador junction and along the upper reaches of the Amazon system; but as far as can be ascertained no serious consideration has been given to testing out the prospects. Any production procured there certainly would present a problem in transportation.

The manifold system at the El Centro pump station of the Andian pipe line

A Complete Line of Refinery Refrigerating Equipment

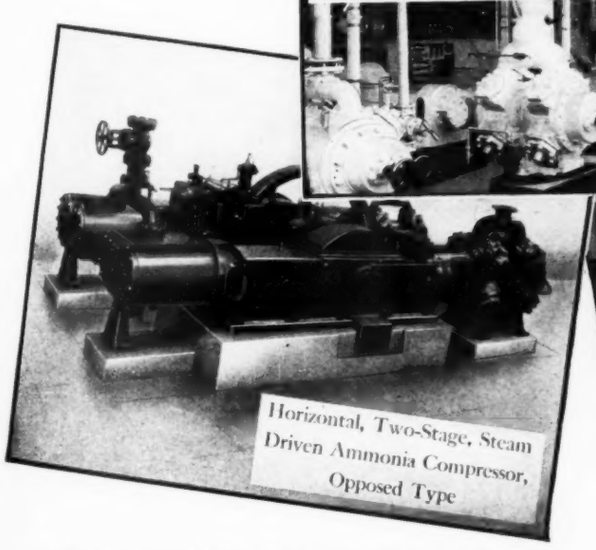


Horizontal Two-Stage Uniflow Steam Engine Driven, Ammonia Compressor, Extended Type

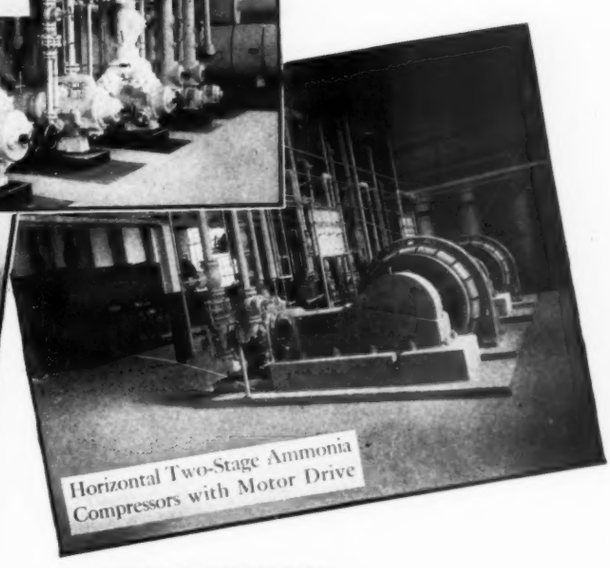


Horizontal Two-Stage Ammonia Compressor with Double Seal Stuffing Box and Capacity Control, Motor Driven

Two Horizontal Two-Stage Carbondale Ammonia Compressors with Capacity Control



Horizontal, Two-Stage, Steam Driven Ammonia Compressor, Opposed Type



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Panoramic view of El Centro, Colombia. Left to right: Gas plant and general offices, married men's quarters on hill, power plant, garage, machine shops and industrial area, dehydration plant, commissary, and foreign staff quarters

El Centro, The Oil Producing Center

Virtually all oil produced in Colombia is from the La Cira and Infantas fields — Interesting production methods employed — Crude transported to tidewater by pipe line — Details of gas and gasoline plant operations

PRACTICALLY all oil produced in Colombia at the present time comes from the La Cira and Infantas fields, which are operated by the Tropical Oil Company whose headquarters, camp, plants, and shops are at El Centro. This active area is almost 500 kilometers south of Barranquilla and lies just off the Magdalena River. The general location is shown in Fig. 1 of introductory article on Colombia, and the relative locations of the two fields and El Centro are given in Fig. 1 of this article. Connection with the river port of Barranca Bermeja is by a narrow gauge railway 27 kilometers in length over which all equipment and supplies are hauled after being unloaded from the river boats that transport them from ports on the sea coast.

The crude oil produced in the fields is piped to tide water. Materials received at El Centro have to come up the Magdalena River, which winds and meanders through a broad valley with numerous branches and lakes spread out over the low-lying land. Bars frequently form in the channels and boats sometimes get hung up on them. In the rainy season it is always possible to get the boats up the river; but in the dry season this cannot always be done. This makes the source of supply for tools and machinery even more remote than in most other South American oil-producing areas and has necessitated the provision of greater facilities for making equipment available and for doing far more extensive repair work than otherwise would be required.

All work in the shops is done by Colombians with Colombian foremen in charge of groups under the supervision of foreigners with specialized training. The machine shop is completely equipped for all types of repair work and for making things that could not otherwise be procured. There is a foundry in which castings up to 1100 lb. can be poured. It has a 500-lb. steel furnace and 3500 lb. per hour can be poured out of a cast-iron cupalo. The foundry is coke-fired and is operated by two moulders and a foreign foreman.

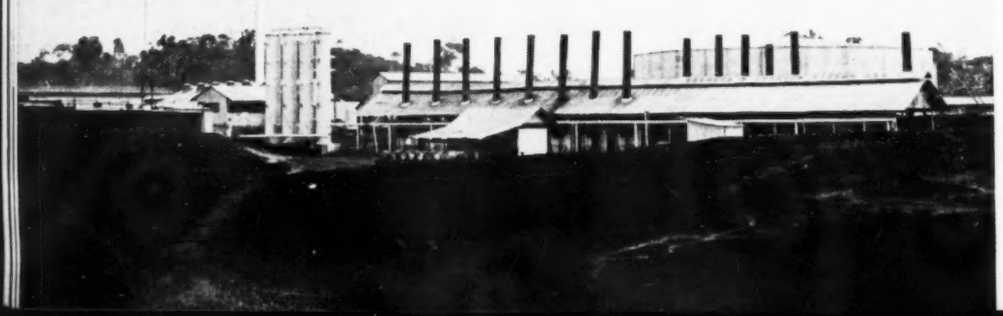
The blacksmith shop is equipped with a 3400-lb. steam hammer. There is also a 1500-lb. hammer for driving fish-tail bits and small forgings, and a 600-lb. hammer for light forgings. In the boiler and welding shop there is a crew of one foreign and 15 Colombian welders. Both gas-welding and arc-welding are employed and propane is used for cutting. There are always men in training for this work.

Pipe for field operations is prepared in a pipe machine and perforating shop. Here are two machines, an 18-in. and a 12½-in., which are used for cutting nipples up to 18 inches. In addition, there are a 4-in. single-head and a 1¼-in. double-head machine in the machine shop for all small nipple work. All casing or liner is slotted in the pipe shops with five perforating machines equipped with 60 mesh cutters. The machines are all operated by Colombians.

Electric current for all operations at El Centro and in the fields is supplied by a generating plant. Electric motors are employed in the pumping of wells and practically all other operations except drilling and gas compression.

As in all other South American countries, an adequate and good water supply has to be provided for drinking, boilers, laundry, showers, and other purposes. A high-pressure water station was therefore erected on the Colorado River at a point nine kilometers from El Centro. Water is pumped to this station from clear streams about two kilometers farther on through a low-pressure 10-in. line.

The water coming into the station is treated with alum, then passed through a settling basin and from there



General view of dehydration plant at El Centro, showing some of tankage to left

through a rapid-filter system. After filtering, it goes to storage and is chlorinated before being pumped away for use. All operations at El Centro and in both fields are supplied with treated water by three 8-in. lines under a pump pressure at the plant of 225 lb. per sq. inch.

Infantas and La Cira Fields

THE discovery of the Infantas field resulted from seepages at a fault on a river near the present developed field. Now that the heavy undergrowth (or monte) has been cleared away for road work and other operations, the fault and oil seepages can be picked up at various places. As shown in Fig. 1, this fault runs in a general north-south direction. It is an underthrust and a deep test now is being drilled near the fault on the top of the structure that probably will go into the underthrust. One deep test was drilled into the Cretaceous during the past year but was stopped in salt water before reaching 5000 feet. The deepest hole yet put down in the field reached about 6000 feet.

Production in the La Cira field is obtained from three sands and in the Infantas field from two sands. The "A" sand is found in the high part of the La Cira field and produces an oil of 20 deg. gravity A.P.I. The "B" sand is found in both the La Cira and Infantas fields and produces an oil of 24-25 deg. gravity A.P.I. The "C" sand in both fields is streaked and produces oil with a gravity ranging from 24 to 28 deg. A.P.I. There is usually a break between the "B" and "C" sands but at some places they are very close together. At others, the distance from the top of the "B" sand to the top of the "C" sand is as great as 1200 feet. Wells drilled to completion in the "C" sand range in total depth from 1600 to 4000 feet.

The spacing is about one well to 17 acres. Some locations are very difficult to prepare. Dense jungle growth usually has to be cleared and roads themselves have to be cut to the well site through it. Road-making often involves considerable shovel work on the hilly terrain and most well locations require excavation. The trees are cut into timber in the company's saw mill and must be hauled away before any lines are run or pipe is laid.

Mud used during drilling is kept at about 80 lb. per cu. ft. and in deep tests blow-out preventers are used. The latest deep test, shown in the photographs during the rigging-up period, has a 12-ft. cellar above which is placed a steel sub-base. New drilling equipment is now being moved in for future operations.

In designing the concrete foundation for the engine, provision is made to take the drilling engine sub-base and make it serve also as a foundation for the pumping unit after a well is finished. When the pumping unit is installed, the derrick is merely lowered 30 in. from the drilling position. Pumping units are set up at each well as soon as it is completed, even though the well comes in as a flowing well.

The casing program used in both fields is indicated by Fig. 2. After running and cementing the 13⅝-in. surface string, open hole is carried through the sand to be produced. A 6⅝-in. combination string is then run and cemented through perforations just above the sand. When upper sands are passed through to penetrate a lower zone, the cement is carried up behind the pipe to a point above the upper sands, thus they are cemented off and protected. That portion of the combination string lying opposite the producing sand is slotted.

In one exploratory edge well drilled to locate the water line, the casing was cemented through the sand and then gun-perforated at desired points to determine the formation content. Gun perforation has also been used in a number of old wells to produce from upper zones previously cased off, and will be described later.

A new deep test location being rigged up in the Infantas field near the fault on the top of the structure. Probably will drill to underthrust and can go 10,000 ft. if necessary

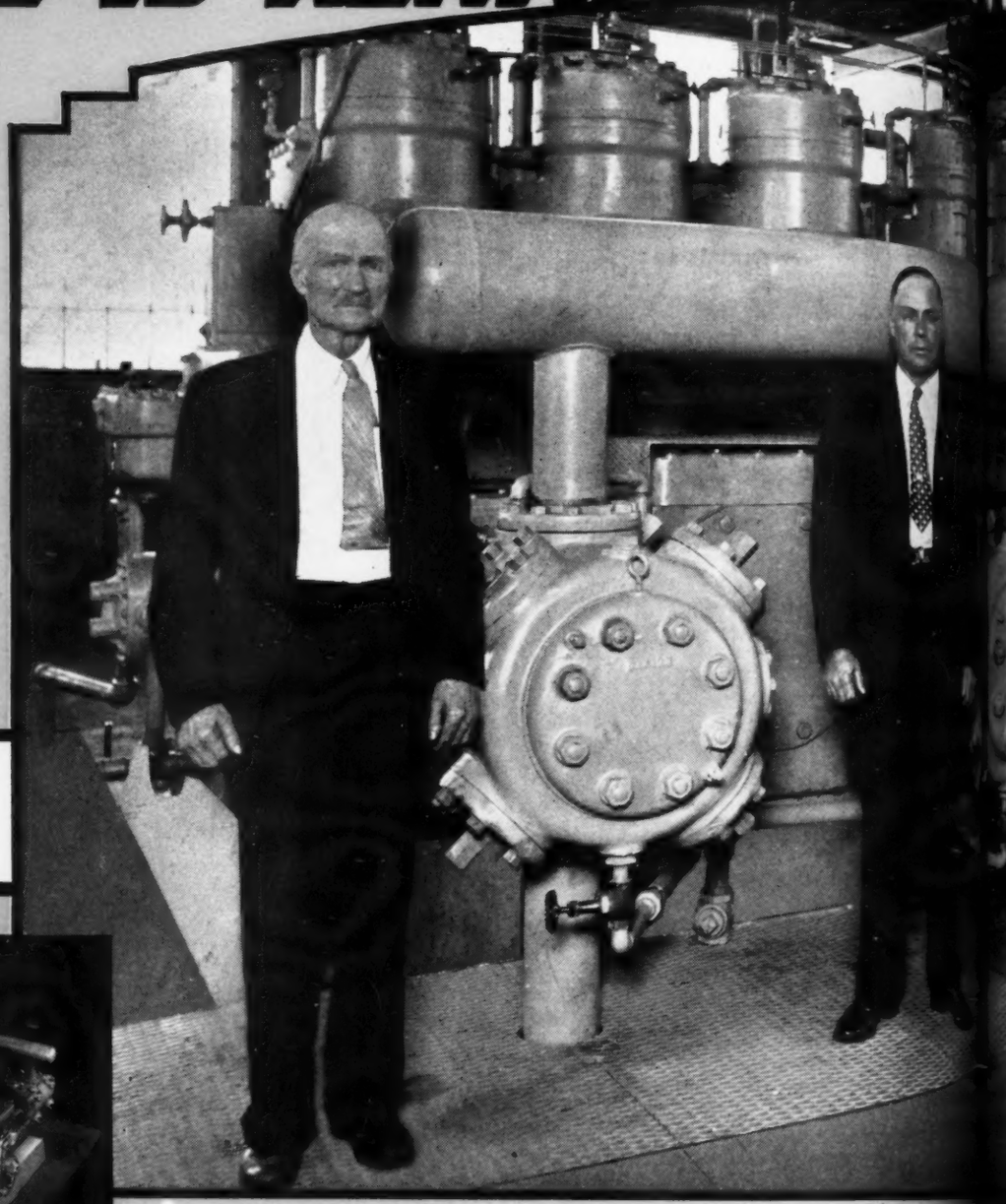
Production From Fields

Wells are brought in by swabbing through 2½-in. tubing. Flowing wells sometimes flow for five years or more but generally go on the pump in about one year. Of 571 wells in the field, 33 are now flowing and 538 are on the pump. The gas/oil ratio at the present time averages 1200 cu. ft. per bbl. for both fields. As already mentioned, pumping units are installed as soon as the well is connected up and the units

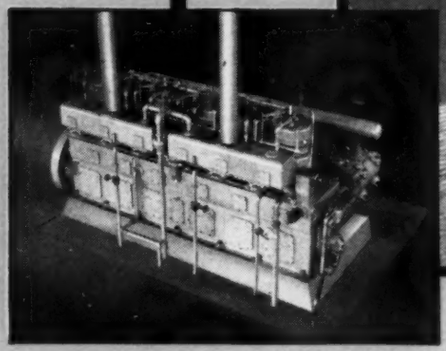
(Continued on page 130)

A pumping unit set on a concrete base designed for both drilling engine and pumping unit. Pumping unit is installed as soon as well is completed and left standing while well is flowing, ready to connect up when needed. The well in the picture is flowing

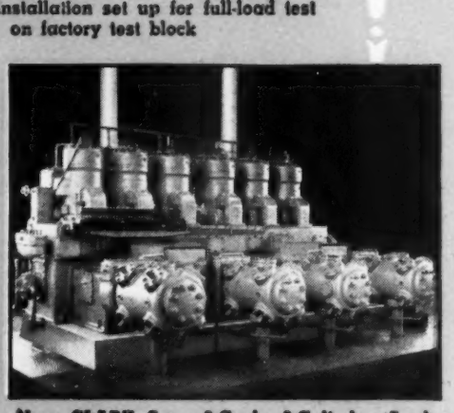
THERE IS ALWAYS A N



4 generations representing 116 years of service in the CLARK shops. Left to right, they are Frank DeLong, 61 years of service; John



6-Cylinder installation set up for full-load test on factory test block



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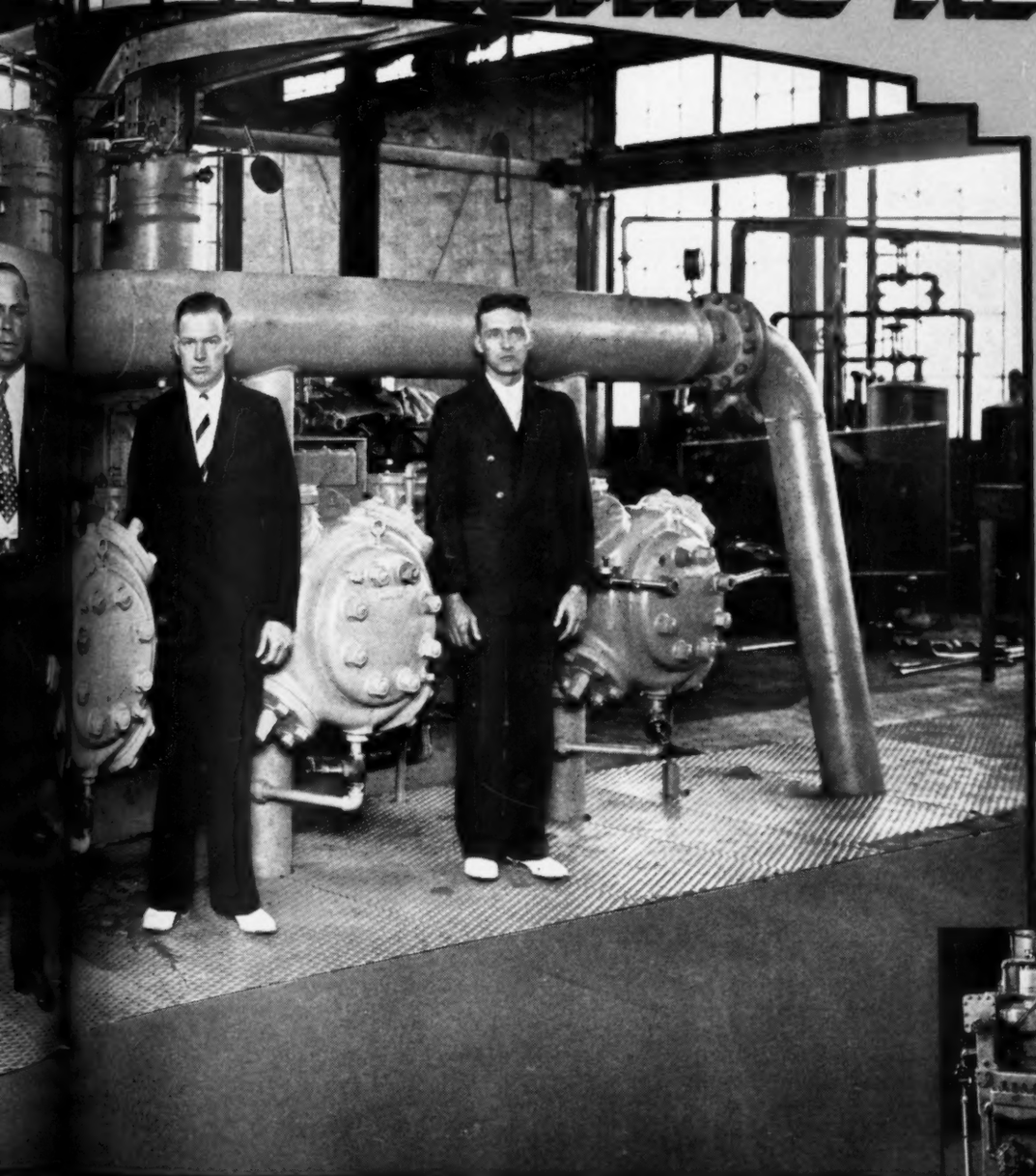
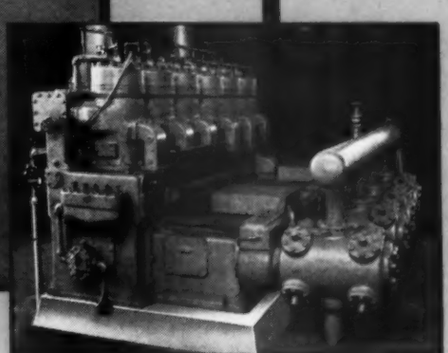


DeLong, son, 36 years of service; Frank Davie, grandson, 15 years; Robert Giberson, great-grand son, 4 years.



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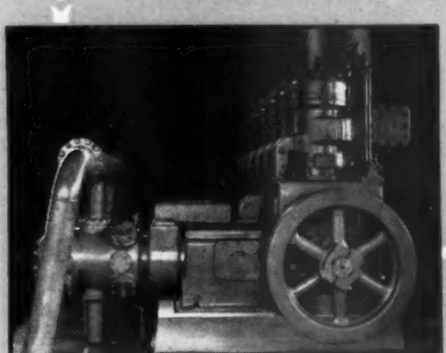

Side View New "CLARK Super-2-Angle" in 6-Cylinder Size

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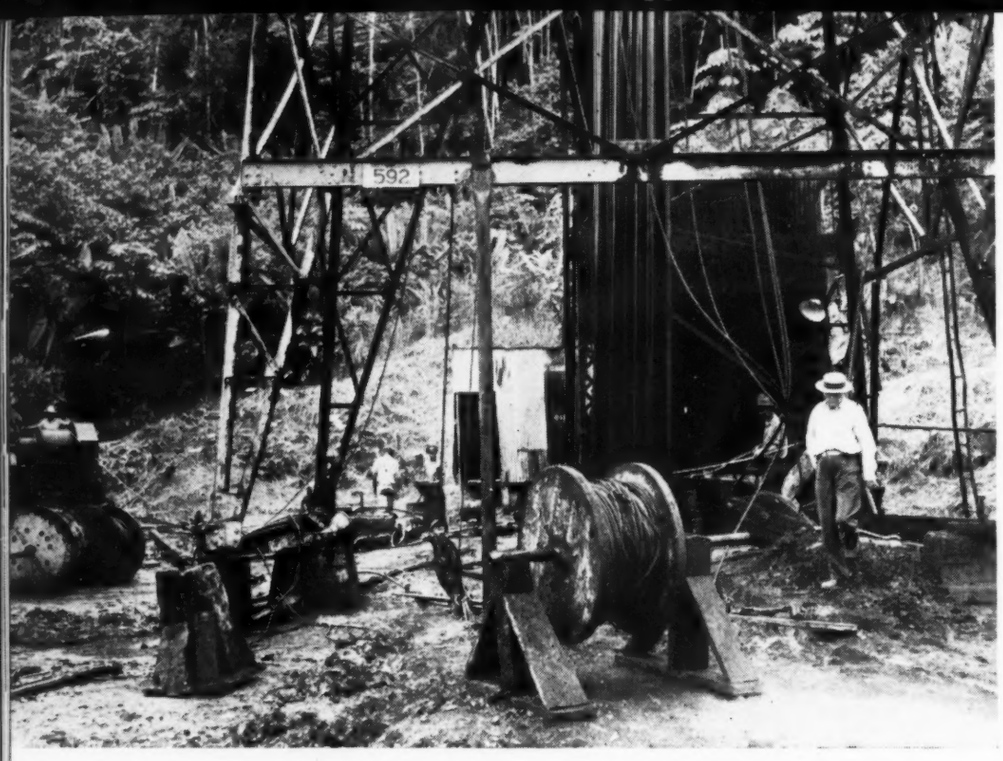
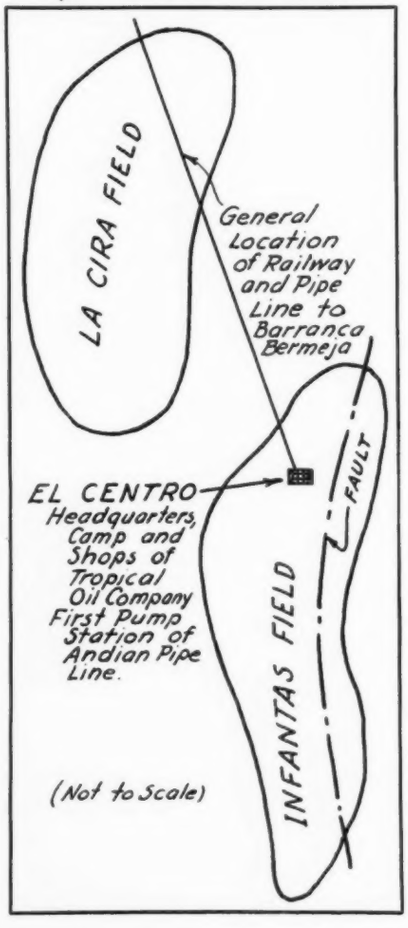


Cleaning out a well in the La Cira field with electric hoist. Ray Armstrong, assistant field manager, Tropical Oil Company, in white shirt and straw hat

(Continued from page 127)

are left in place during the flowing period even though the flowing life of the well is expected to be rather long. By this procedure any delay in getting a well on the pump due to lack of equipment is avoided.

Fig. 1. The La Cira and Infantas fields to the present time have been developed over the areas outlined

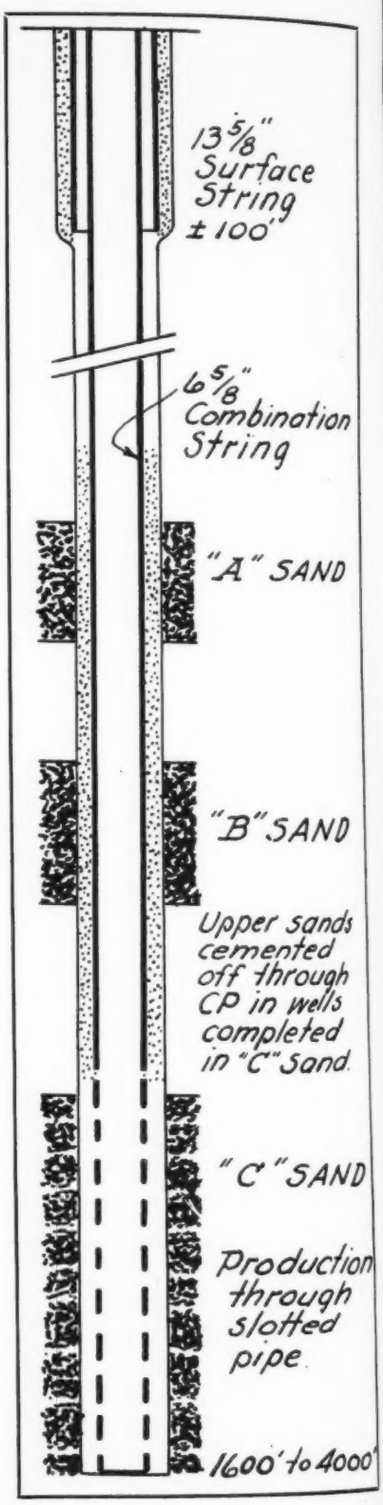

LA CIRA FIELD
General Location of Railway and Pipe Line to Barranca Bermeja
EL CENTRO
Headquarters, Camp and Shops of Tropical Oil Company
First Pump Station of Andian Pipe Line.
FAULT
INFANTAS FIELD
(Not to Scale)

In addition to the wells equipped with individual pumping units there are two old central pumping powers. Besides overcoming handicaps offered by the topography and the heavy undergrowth, the individual pumping units, it is believed, provide more economical service. The pumping conditions encountered in the fields vary widely and pump speed and stroke are determined with care in order to obtain most efficient operation. The strokes of pumping wells vary from 12 in. to 60 in.; the speed ranges from the exceedingly slow speed of two strokes per minute up to 24 strokes per minute. The motors used range from 1 hp. up to 15 hp. with a very few as large as 20 horsepower. Continuous pumping is favored over intermittent pumping even in the very small wells and by careful study of pumping conditions the individual pumping units have been installed and powered in a way to insure greatest economy with maximum production.

In a typical gathering station two large separators handle the oil and gas from a number of wells and a small separator is used for testing. There is a 16-ft. drop with a liquid seal from the separators to the tanks. At this station, one separator handles clean oil and other emulsified oil. The four tanks are of 500-bbl. capacity but at some stations 250-bbl. tanks are used. A manifold system at each station provides for flexibility in routing the oil and gas from the various wells.

Clean-out jobs are frequently done with an electrical hoist. Operations on the derrick floor in well repair work or cleaning out are handicapped by there not being any floor. Termites will eat away wooden flooring within a year and there is no use in leaving

Fig. 2. Casing program for wells completed in the "C" sand at La Cira and Infantas fields


13 5/8" Surface String ± 100'
6 5/8" Combination String
"A" SAND
"B" SAND
Upper sands cemented off through CP in wells completed in "C" Sand
"C" SAND
Production through slotted pipe
1600' to 4000'

Water tanks and pump station on Colorado River supplying water to fields and El Centro operations

such flooring on the well after it is completed. Moreover, wood rots rapidly and will disintegrate within a short time. The arrangement of the pumping unit on its concrete base and with only metal and concrete left at the producing well has been found the most satisfactory procedure to follow. This is clearly shown in the picture of the flowing well equipped with a pumping unit ready for hooking-up when the well is to go on the pump.

The production from the older wells has been increased considerably during the past year by gun-perforating upper sands that had been cased off when the wells were completed in lower zones. More than 100 wells have been so treated. The procedures followed after shooting opposite the upper zone are either to plug off the lower zone or to produce both the upper and lower zones together. The plan followed depends on the gas condition in the lower zone at the particular well being perforated.

The oil from the fields has a gravity that averages 25.3 deg. A.P.I. clean oil. Considerable care is taken in treating the oil, and of the actual oil put into the line at the field, the cut averages less than 0.2 percent. This despite the fact that, although the emulsion separates easily, it takes a long time to settle out. The average time required for settling is 48 hours but in extreme cases it takes five days.

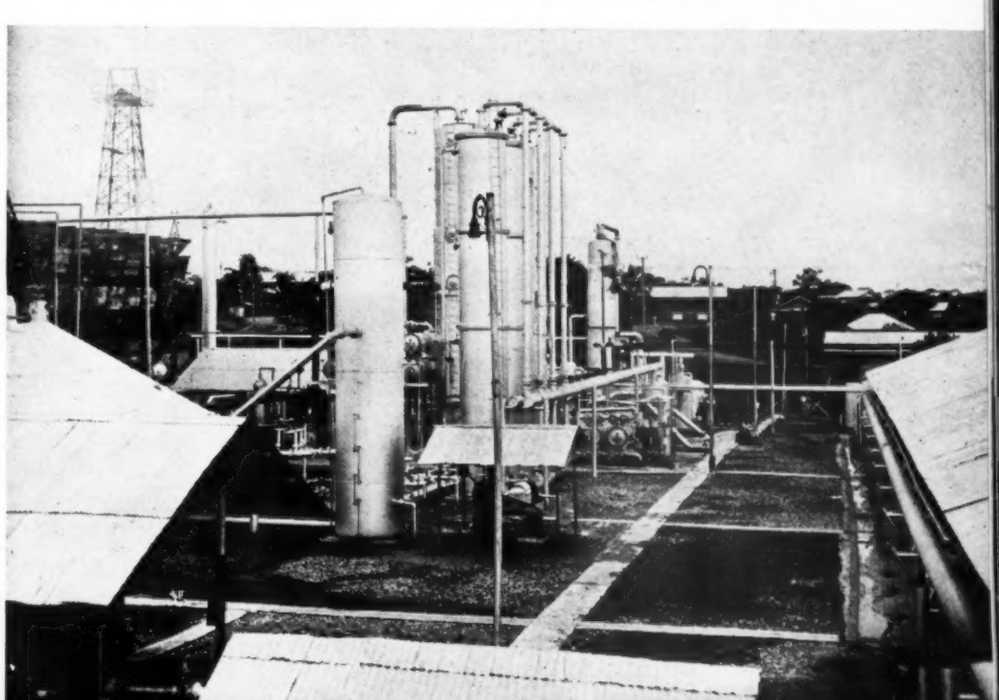
The dehydration plant consists mainly of a battery of boilers, stripping towers, a treating house, and considerable storage. Chemical treatment is used and the chemical is introduced either before or after scrubbing. It does not seem to make any difference which method is used but at the present time the chemical is being introduced into the oil stream after it passes through the stripping towers. About 30,000 bbl. daily is now going through the plant.

The oil is first heated to 160 deg. fahr. and then goes to the stripping towers through inlets at either of two levels. After leaving the towers it passes through the treating house where the chemical is added and from there the treated oil goes to the settling tanks. To facilitate the operation it has been found expedient to pass about half clean oil and half wet oil through the plant; this aids in knocking out the water. In addition to the main plant at El Centro there is a cold dehydration plant in the field that handles from 2000 to 3000 bbl. of oil per day.

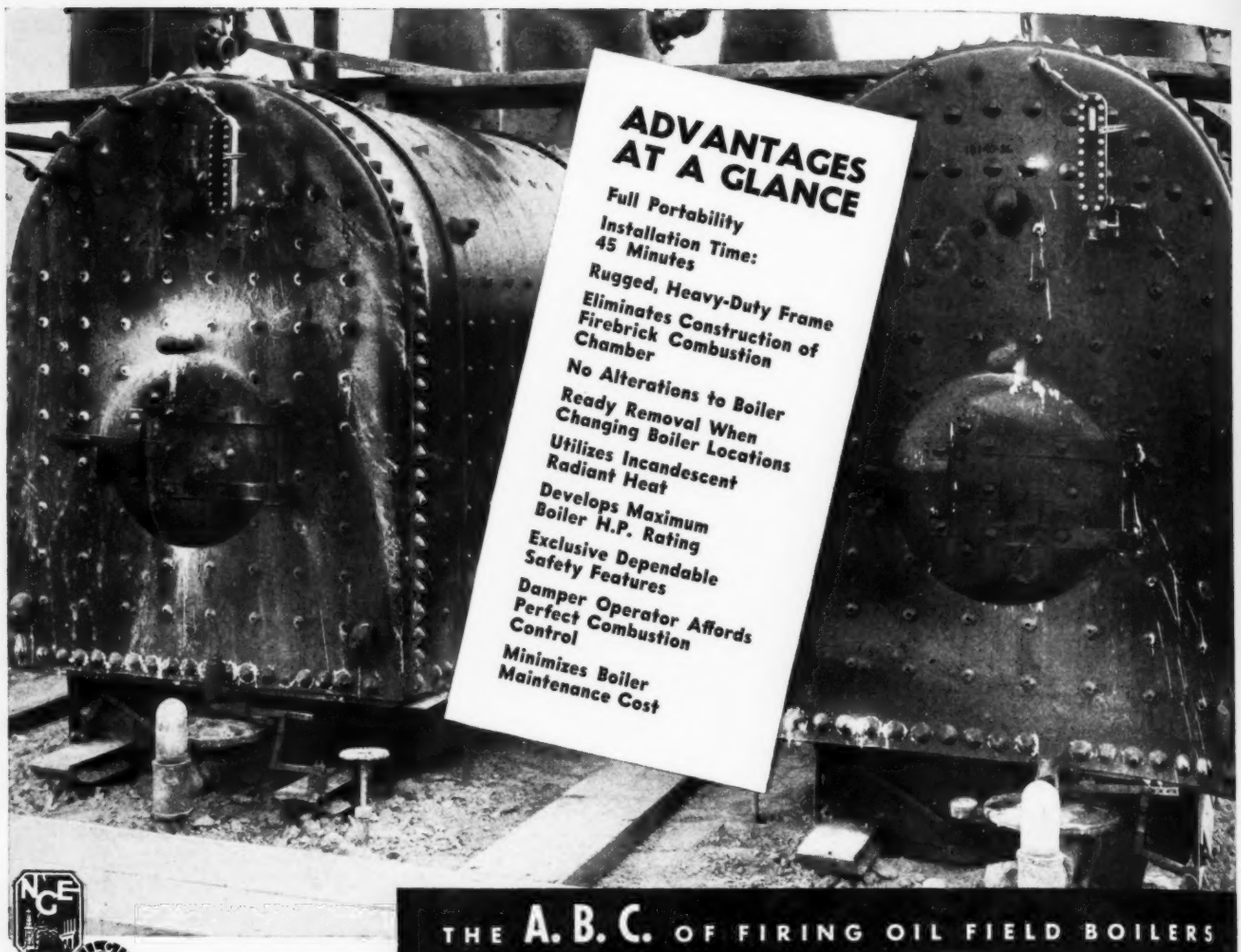
Gas and Gasoline Plants

Though distillation and stabilization of gasoline made from the gas produced in the Infantas and La Cira fields are carried out in the main gasoline plant at El Centro, absorption is carried out in towers erected at compressor stations in the field. There are three of these compression stations in the Infantas field and two in the La Cira field, one of the former being adjacent to the main gasoline plant at El Centro. Mineral seal oil for absorption is pumped from the El Centro plant through a 4-in. line and the fat oil after passing through the absorber at the field compressor plant is returned to El Centro through another 4-in. line. The line pressure on the rich mineral seal oil is maintained at 300 lb. per sq. inch. The lean oil enters the field absorbers at the different plants at varying pressures, the absorption pressures not being the same at all plants. The absorption plant at El Centro, however, is a separate unit and has its own distillation unit.

The gas from the field enters the compressor stations at from 10 to 12-in. vacuum and is compressed to 90 or 100 lb. per sq. in. gauge. It then passes through the absorbers and the residue, which is used for repressuring, is boosted to 400 to 500-lb. pressure. Only the "C" sand is repressured in both fields and 24,000 M cu. ft. of gas per day is used for that purpose. There are 6500 M cu. ft. of gas consumed as field fuel, 4500 M cu. ft. utilized as plant fuel and 3000 M cu. ft. piped to Barranca Bermeja. From the gas processed approximately 80,-



The absorber, distillation unit, and booster distillation unit, El Centro gasoline plant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Eliminates Construction of Firebrick Combustion Chamber
No Alterations to Boiler
Ready Removal When Changing Boiler Locations
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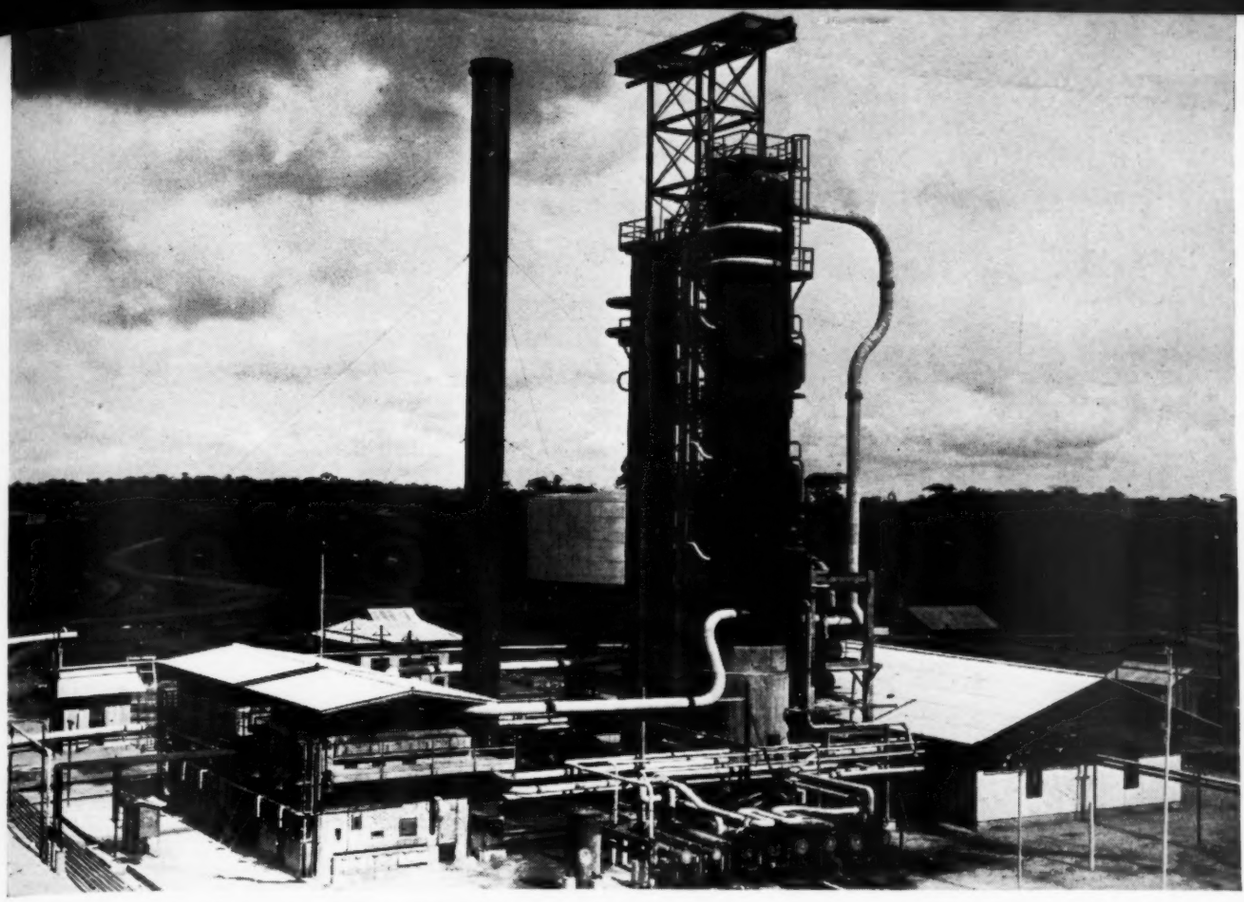


Distillation unit at Barranca Bermeja refinery of Tropical Oil Company, showing water-cooling tower in background

000 gal. of gasoline is extracted. As in all other operations in South America, no gas is wasted; what is not used efficiently in plant and field operations goes back into the sand for maintaining pressure.

Considerable advantage is believed to result from carrying out all distillation at the main plant at El Centro, having the absorbers at the compressor stations and the mineral seal oil pumped back and forth. Very little loss of absorption oil has been experienced and greater efficiency in operation is believed to have been accompanied by economy. All field plants are operated by Colombians with a foreign supervisor in each district. At the El Centro plant there is only one foreign operator on each shift.

Of the natural gasoline manufactured at El Centro, a considerable amount is a 12-lb. vapor-pressure product that is shipped to the refinery at Barranca Bermeja and used for the manufacture of gasoline consumed in Colombia. This is transported under a pressure of 250 lb. from the field to the refinery by a 3-in. line 27 kilometers long. The remainder is blended with the crude oil piped to tidewater for export.

All oxygen for use in the field and shops is made at the El Centro plant. Propane gas from the stabilizer is employed for cutting and some of this is run direct from the stabilizers to the welding shop where it is taken right out of the line through regulators. Bottled acetylene gas is supplied by carbide generators also installed at the plant.

Operations at Barranca Bermeja

Equipment and materials for operations at El Centro and the fields are unloaded at Barranca Bermeja from river boats plying the Magdalena River. The Tropical Oil Co. has its own fleet of boats but others also carry goods to this river port. Most freight comes from Cartagena via Calamar on the Magdalena but some comes from Barranquilla, which is itself on the river.

At Barranca Bermeja, headquarters of the narrow-gauge railroad operations, engines and trains to and from El Centro are dispatched and equipment maintained. Included is a roundhouse as well as repair shops. Here too is a power plant that supplies current for all the electrical operations of the company at this location. Fuel gas is supplied from the La Cira and Infantas fields.

In the power plant are six 202-hp. boilers and two 250-hp. boilers. Power is supplied by one 1000-kw. generator and three 200-kw. generators. The power lines from this plant and the one at El Centro are so strung that each station can supplement the other and thus provide a flexibility in handling peak loads at either place without necessitating the installation of excess equipment. At the power plant there are also an ice plant and air compressors.

Water for Barranca Bermeja operations is supplied by a small lake that is about two miles distant. Drinking water comes from wells and storage is provided by a water tower.

The products of the Tropical Oil Company refinery at Barranca Bermeja are sold locally. Crude oil from Infantas and La Cira fields is piped to the refinery from El Centro. Gasoline for use in El Centro operations is taken back by small tank cars on the narrow-gauge railway.

A modern refinery, equipped with an atmospheric and vacuum flash coil, produces aviation gasoline, motor gaso-

line, kerosene, light gas oil, lubricating distillate, and heavier fuels. Lubricating distillate is fractionated in a vacuum flash coil and phenol-treated to specifications demanded for superior grade lubricating oils in the North American market. Supplementary stills produce the liquid and solid asphalts marketed in Colombia.

In addition to the regular gasoline manufactured at the refinery, aviation gasolines with octane rating of from 84 to 87 are also made.

The company manufacturers its own 18-gauge "one-way" containers and 5-gallon cans for shipment of products. It also makes the lighter drums for the solid asphalt. Products shipped in cans or in cases containing two cans are gasoline, kerosene, lube oils, and painters' solvents. Shipments of refined products are also made in larger drums or barrels and in bulk.

Filling of containers is done in a well-organized plant with conveyors carrying the material from one operation to the other.

Shipments depend to a great extent on the Magdalena River. Boats frequently get stuck on a sand bar up the river and the same thing often occurs down the river, during the dry season.

Transportation . . . From Interior to Coast

CRUDE oil from the Infantas and La Cira fields is transported through a 537-kilometer pipe line that runs up the Magdalena Valley from El Centro to a tanker loading terminal at Mamonal, ten miles southwest of Cartagena on the Caribbean Sea. This line, operated by the Andian National Corporation, was completed in April, 1925, and the first oil passed through it on July 26, 1926. The capacity of the pipe line is around 50,000 bbl. daily.

The laying of this line was done under great difficulties because it follows the general course of the Magdalena River over most of its distance. The valley of the river is covered with lakes and swamps. Tributary streams and inlets required numerous crossings and some of the pump stations had to be built on pile foundations. The pipe line crosses the Magdalena River itself at one point.

Maintenance of the line naturally is very high. Soil corrosion has to be combatted constantly. Sections frequently have to be raised above ground and pit-holes welded. At least 60 percent of the line is under water during the wet season. Crews have to use launches and mules or go on foot when covering the line; at times they have to employ canoes. All work is done by Colombian employees under the direction of a foreign line foreman in charge of each section.

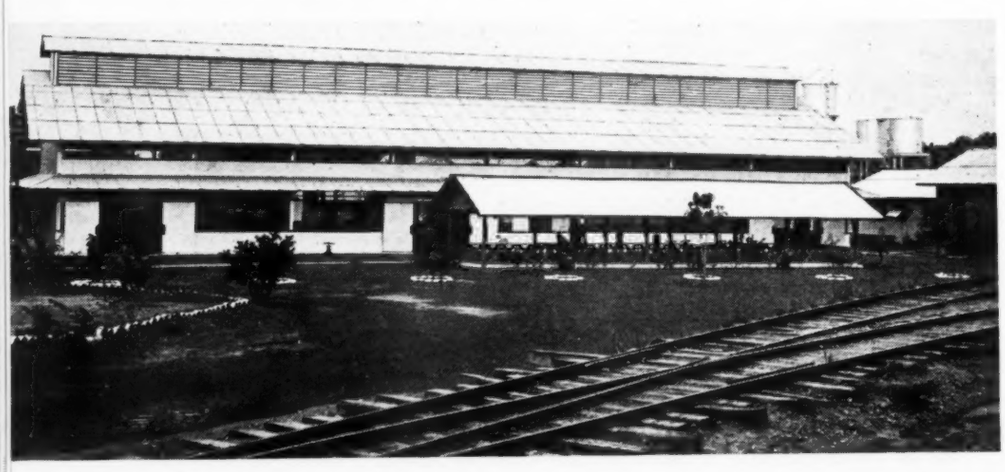
In addition to the loading pump station at Mamonal, there are nine other stations on the line. The line itself is a complete 10-in. line with 10-in. loops between each station. This makes a double line for all but about seven miles over the entire distance of 537 kilometers. The increased capacity thus provided probably greatly exceeds the 50,000-bbl. rating.

Communication along the extent of the line is important and a metallic phone circuit is maintained over the entire distance. Radio, however, has also been installed with transmitters at alternate stations and receivers at every station. This provides a means of communication in case the telephone system gets out of order.

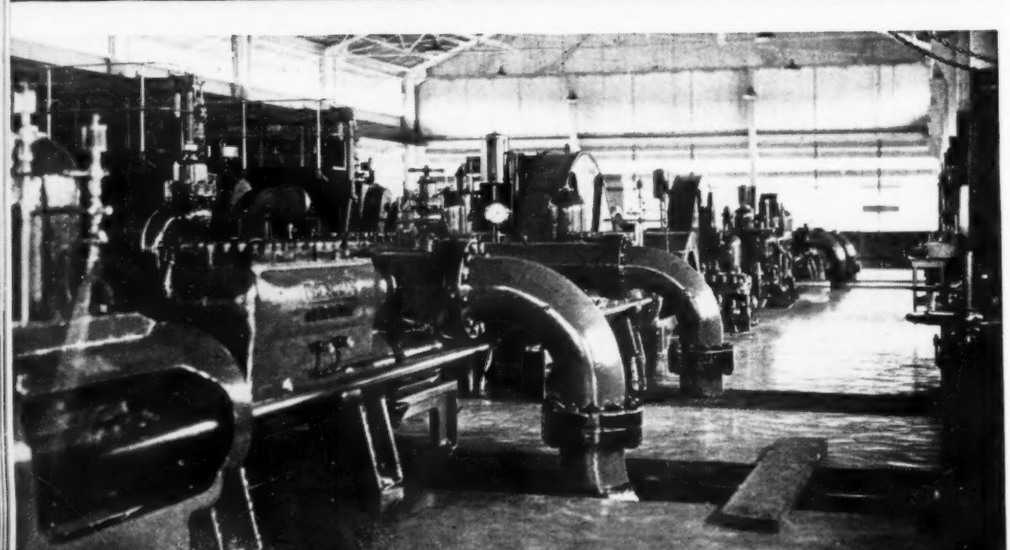
Oil from the field enters the line at El Centro, where the pump station is equipped with four pumping units consisting of 260-hp. Diesel engines driving 5½ by 24 reciprocating pumps. At two stations on the line, the oil is pumped by three 500-hp. units and at the other six stations by two 500-hp. and two 200-hp. horizontal units. The discharge pressure at El Centro is 550 lb. per sq. in., all that is necessary for the short distance to the next station near Barranca Bermeja. The pressure on the line varies but at other stations the discharge pressure is sometimes as high as 625 lb. per sq. inch.

In the loading station at Mamonal four units handle the loading of tankers. These consist of 260-hp., 4-cycle vertical engines driving 11½ by 24 pumps. The capacity of these units is 10,000 bbl. an hour. Crude oil is pumped through two 12-in. lines laid on a pier extending to deep water and most ships use both lines in loading. A 10-in. line is also on the pier and serves for loading fuel oil and bunker fuel. Another 10-in. line is a ballast line. Diesel oil supplied by this terminal is carried to the ships on barges.

Storage at Mamonal consists of fifteen 80,000-bbl. tanks for shipment to world markets.



The Andian National Corporation pump station at El Centro, where the crude oil is started on its long trip to Cartagena (Mamonal Terminal)



Inside the pump station at El Centro

Negritos, Peru. In foreground, the school provided for Peruvian children; in background, shops, offices, and foreign camp

Production and Refining Methods in Peru are Highly Developed

Peru was the first country in South America to produce oil, and production has increased consistently since

WITH oil production first reported in 1884, Peru became the first oil-producing country in South America. Its volume of production has increased consistently since that time and during the year of 1936 a record of more than 17,000,000 bbl. of oil was reached. The probabilities are that 1937 production will exceed that of 1936 and that the position of third largest oil-producing country in South America will be maintained. Moreover, a complete refinery with cracking plant is operated at Talara and is manufacturing lube oil and asphalts as well as gasoline and lighter fractions both for consumption within the country and for export.

More than 15,000,000 bbl. of last year's production came from the Negritos district operated by the International Petroleum Company, Ltd. Most of the remainder was from the Lobitos district operated by Compania Petrolera Lobitos, an English owned and controlled organization. Approximately 50,000 bbl. were produced by the Zorritos field operated by Piaggio and Company, an Italian concern. These areas, together with the location of a wildcat well being drilled by the government, are shown in Fig. 1.

The fields lie in a narrow coastal strip on the west coast of South America, the most westerly point of the continent being just south of the Negritos camp. The land is arid with sand constantly being blown into drifts that impede operations. The climate is dry but, due to the cool Humboldt current that flows up the coast from the Antarctic, is very pleasant. The sun, of course, is extremely hot during the day and affects the temperature of crude oil and refined products in storage. The terrain is hilly and, especially to the north in the Lobitos district, is badly broken. Here the difference in surface elevation of wells very close together is sometimes almost 1000 feet.

The soil conditions in the territory where oil is produced are such that burial of pipe lines is not advisable. All lines, therefore, are laid above ground, as can be seen in accompanying illustrations. Salt corrosion is one of the worst factors that has to be dealt with, salt being present to such an extent that in a low area along the coast just south of the Negritos camp a French company collects salt and distributes it for use throughout the country.

Narrow-gauge railways are used almost entirely for the transportation of heavy equipment to well locations. For all new wells, except those drilled with portable machines, track is laid to the site from the main narrow gauge line serving that particular area. This has produced a network of track over both the Negritos and Lobitos districts; but it has facilitated transportation over the sand-blown country and provided for even such operations as cementing, as shown in accompanying illustrations. In the Negritos district asphalt tracks are laid

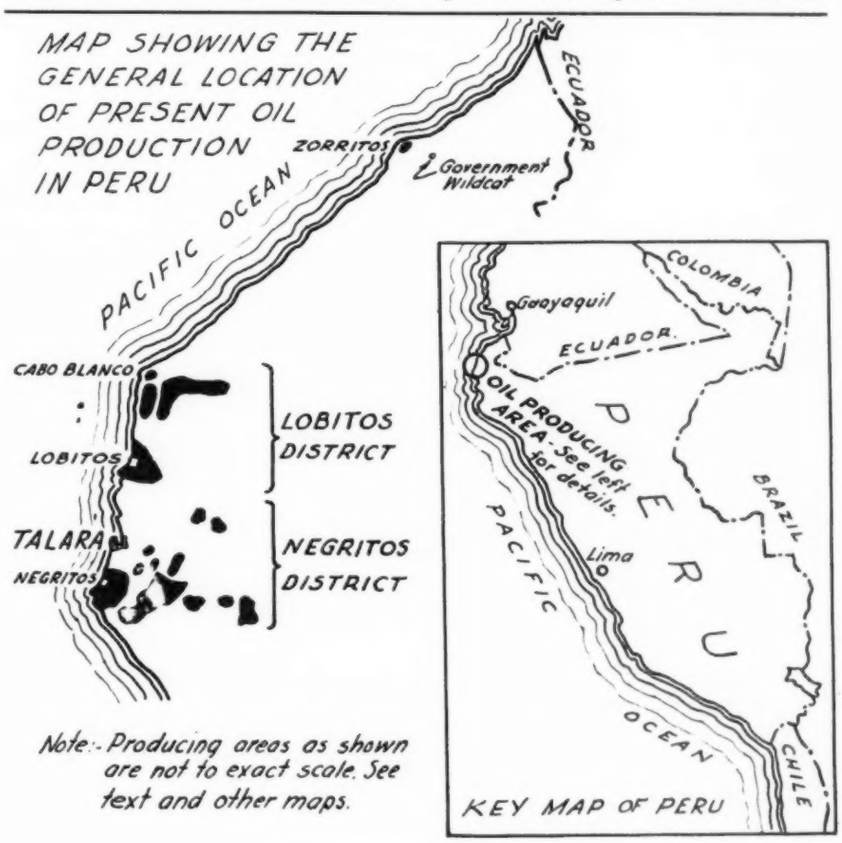


Fig. 1. Map showing location of oil fields in Peru

Section of El Alto area

Tanker tying up at Mole No. 2, Talara, to take cargo of bulk refined products. The end of Mole No. 1 is in foreground

just outside the rails to make a combined railway and automobile road. Between Talara and Negritos such a combined road passes through a tunnel that saves many miles of costly rail and road construction besides shortening the time necessary between these two important points.

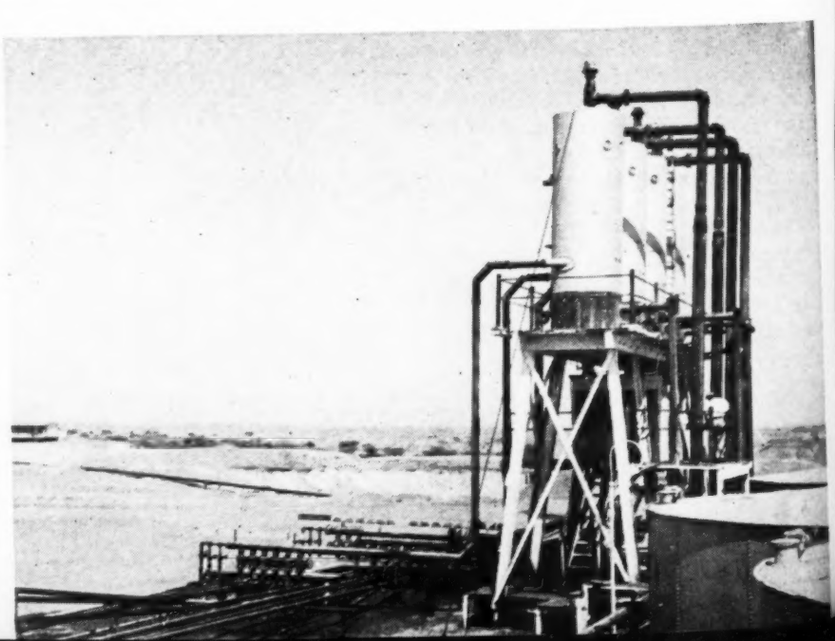
The railroad systems are not public carriers but a passenger train is run by the International Petroleum Company once a week from Talara to the Chira River. On this train Peruvians are allowed to ride without charge and thus have a means of procuring foodstuffs from that source.

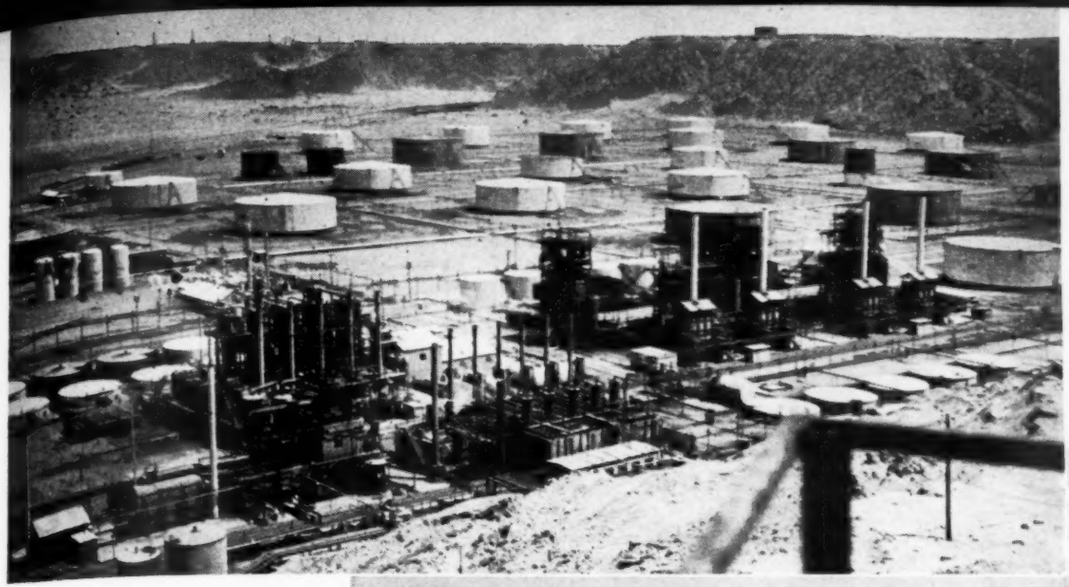
Complete facilities for education, health, and recreation are provided for Peruvians and foreigners by the companies operating the oil fields in and around Talara. In the Negritos district and Talara there are approximately 4000 Peruvians and 210 foreign employees of the International Petroleum Company. Peruvian employees are provided with free houses, light, gas, and fresh water. They live in blocks of six houses, the foremen occupying small bungalows. They have Peruvian clubs and, being enthusiastic over soccer, make good use of stadiums supplied for this and other outdoor sports. The foreign staff consisting of less than 200 families has its own clubhouses and sports; and there is a cinema house at each big camp for both Peruvians and foreigners.

There are schools for both the Peruvian and foreign children. They are situated in all the camps throughout the districts, as well as in the larger settlements. In Talara and Negritos alone there are 80 teachers. Complete hospitals are maintained at Talara and Negritos by the International and, on the top of the escarpment overlooking Cabo Blanco nearly 1000 ft. above the Pacific, is the main hospital of the Compania Petrolera Lobitos. Dressing stations and medicinal supplies are made available throughout the districts.

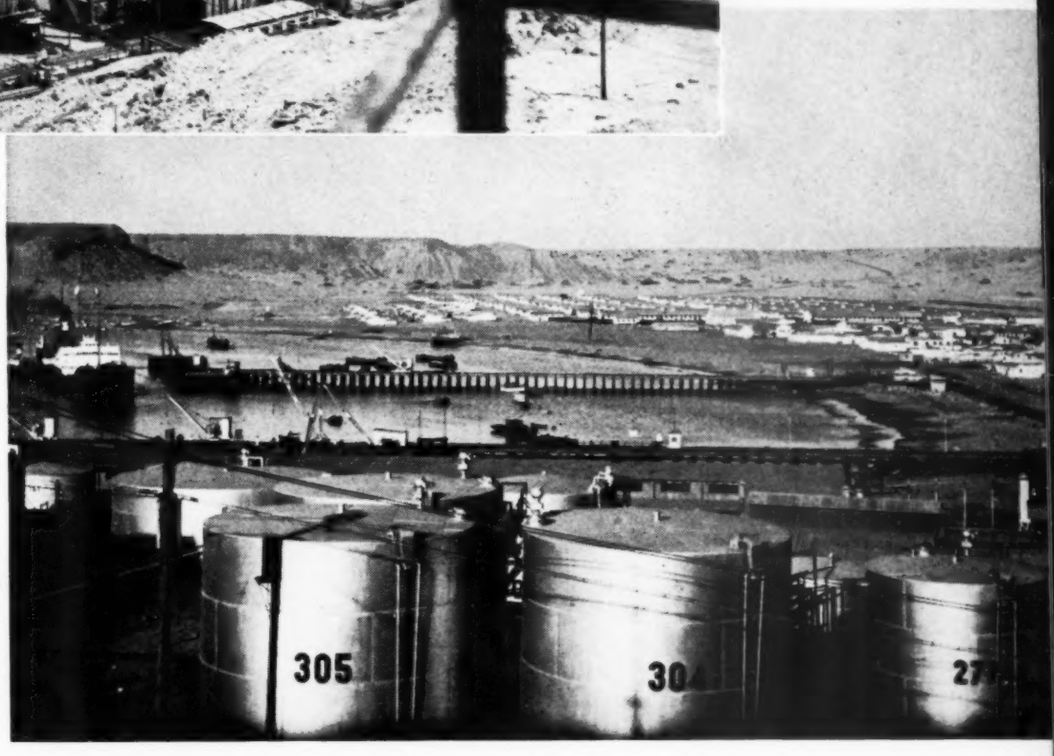
All buildings are built, operated, and maintained by the companies. The camps are not cities but are provided with fire departments, police, and all the other conveniences to be found in cities.

All lines are above ground in Peruvian operations. Here can be seen how they go into a gathering station





Above: General view of refinery and tank farm, Talara, Peru



Right: Tanker at mole, Talara

Talara . . . A Busy Refinery and An Active Port

On what probably is the best equipped harbor on the west coast of South America are situated the refining and export headquarters of the International Petroleum Company, Ltd.

THE refining and export headquarters of International Petroleum Company, Ltd., are at Talara, which lies on what is probably the best equipped harbor on the west coast of South America. Surrounding it on the north and east are barren hills, while to the south is an escarpment over which crude oil from the Negritos district gravitates to a large tank farm.

In the tank farm are tanks that, when including two check-gauge tanks situated on the hill above, provide storage for 2,000,000 bbl. of crude oil and refined products. Most of the tanks are aluminum painted but a number are covered with Guayaquil cane. This material is made up in the form of a jacket and is kept 18 in. out from the metal of the tanks. It is used mainly for gasoline storage and keeps the temperature at from six to eight degrees lower than that in aluminum-painted tanks. There also are two 55,000-bbl. radial-cone pressure tanks for storage of natural gasoline.

The Refinery

The International Petroleum Company refinery has a throughput of 16,000 bbl. daily and manufactures gasoline, kerosene, fuel oil, gas oils, lube oils of all grades, and asphalt. Both high and low cold-test oils are refined but the greater portion run is high cold test. All lube oil is made from low cold-test oil and the various grades are processed under the vacuum flash coil system.

The cracking plant has a capacity of approximately 7000 bbl. daily and is equipped with standard tube and tank units. It is being operated at a pressure of 250 lb. per sq. in. and at a temperature varying from 840 deg. fahr. to that depending on how hard it is desired to crack. In rectifying cracked distillate, a clay tower operation has been found continuous and reliable.

Gasoline is made to standard speci-

Overhead lines in refinery at Talara

plant. The aviation gasoline meets the company's brand specification and, as in all other countries, this grade of gasoline is becoming more in demand.

Natural gasoline made in the Negritos district is piped to the refinery and, in addition to this, 200 bbl. per day are taken from the Lobitos Company. More natural gasoline is received than can be used for blending so the surplus is shipped abroad.

A big road-building program is in progress in Peru and large amounts of asphalt are being supplied for these projects. All types of asphalts are manufactured at the refinery, a considerable portion being solid asphalt that is shipped in sacks. The cooling, breaking, and sacking plant is shown in an accompanying illustration. Here the asphalt is run into large pans with a slow, continuous, hot stream regulated to fill each pan at periodic intervals. The pan first is covered with clay sweepings and a chain laid on the bottom, zig-zagging from side to side. When the asphalt fills the pan and is cold, the chain is pulled by a tractor and breaks up the mass into a form easily handled. The pieces are then put into a breaker and broken to a size suitable for sacking. When pulverized asphalt is desired, a grinding machine provides the necessary product.

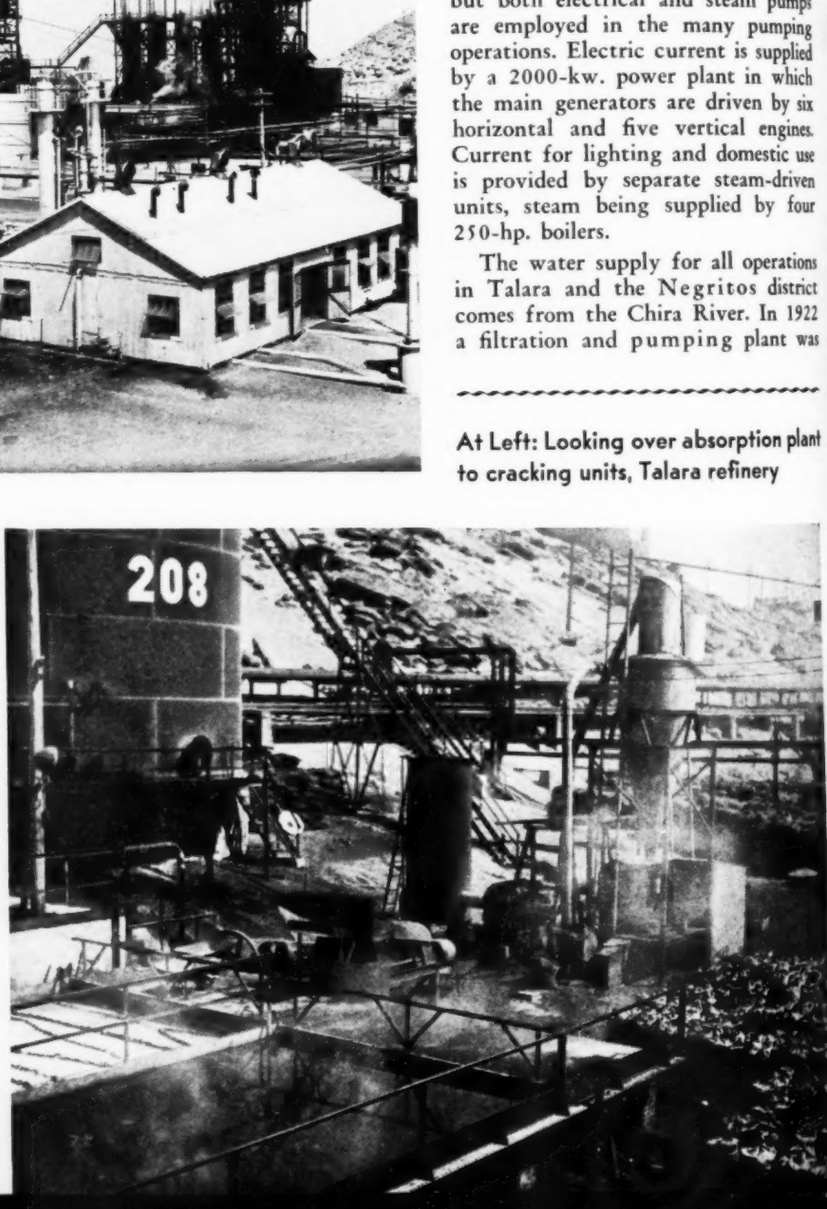
Tail gas from the cracking coils, tube stills, and other departments are stripped in an absorption plant situated behind the cracking plant. All piping is above ground and a considerable portion is overhead. It is felt that the system above ground is much safer than buried lines, which corrode very rapidly when laid in the soil of the type found in this country.

Gas is used for fuel in the refinery but both electrical and steam pumps are employed in the many pumping operations. Electric current is supplied by a 2000-kw. power plant in which the main generators are driven by six horizontal and five vertical engines. Current for lighting and domestic use is provided by separate steam-driven units, steam being supplied by four 250-hp. boilers.

The water supply for all operations in Talara and the Negritos district comes from the Chira River. In 1922 a filtration and pumping plant was

At Left: Looking over absorption plant to cracking units, Talara refinery

fication and aviation gasoline manufactured of any octane rating up to 74 clear and to 87 leaded. The Ethyl is imported in drums for blending at the



Asphalt sacking plant. On right is grinder used when pulverized asphalt is required. To left is a breaker usually employed for sacked asphalt. The pan on left in foreground is being filled with hot asphalt. Note the steam arising. The pan on right has its floor covered with clay sweepings ready to be filled. The chain is covered with the asphalt and after cooling is pulled and breaks the solid material up for convenient handling

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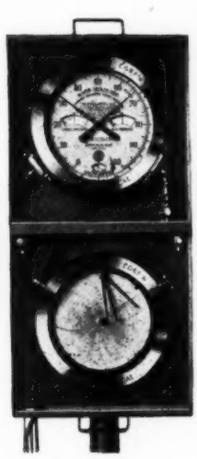
The CLIPPER is the instrument you want for those jobs where you're here today and there tomorrow. An ingenious dial arrangement enables the Clipper to read directly in pounds or points for practically any string-up with all of the standard sized lines. Having both sensitive and super-sensitive gauge hands, it is completely self-contained, requires no adjustments nor "pumping up," is tamper proof, weather proof, leak proof, and weighs only 47 pounds complete. On and off the dead-line in an instant, it is easily transported from rig to rig, making it readily available anywhere on the lease.

The QUINTUPLEX



The QUINTUPLEX is the complete drilling control instrument that centralizes the important drilling functions right under the driller's eyes, and keeps a permanent 24 hour record of drilling progress for future reference. Five separate gauges — regular and super-sensitive weight indicators, mud pressure gauge, rotary table tachometer, and torque indicator — are mounted in one compact case in front of the driller, while a clock-driven chart jots down changes in the weight, mud pressure, and torque the *instant* they occur. The Quintuplex is the instrument you want for modern rotary drilling control, and you will find it used the world over to aid efficient drilling methods.

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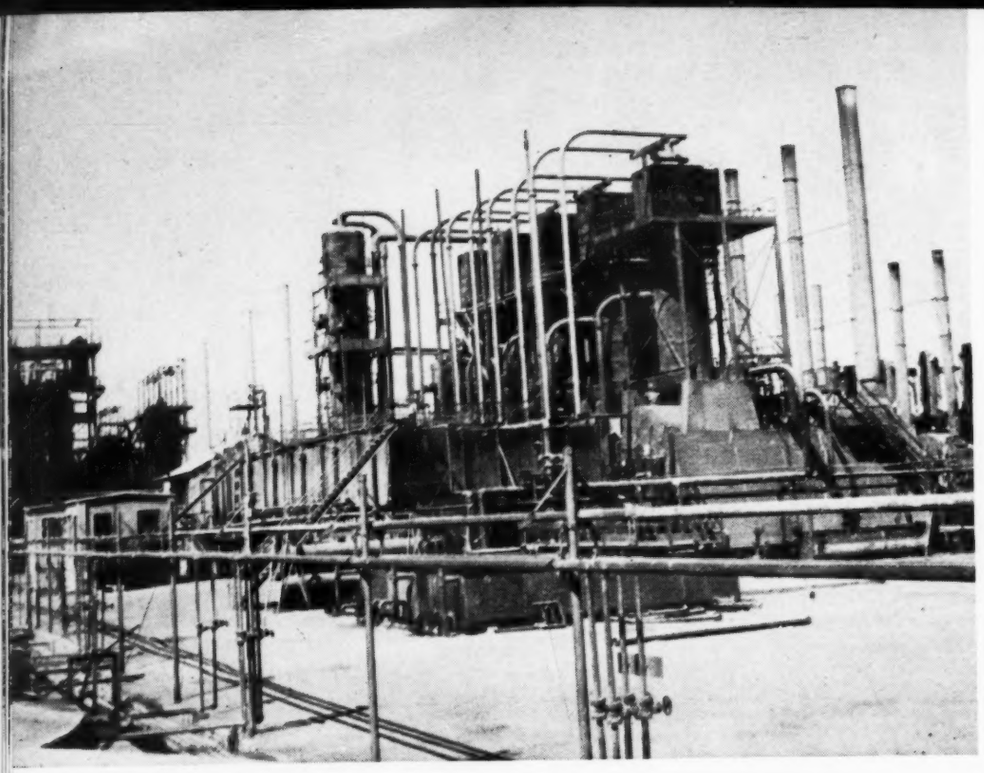


Crude stills in foreground and cracking units in distance, Talara refinery

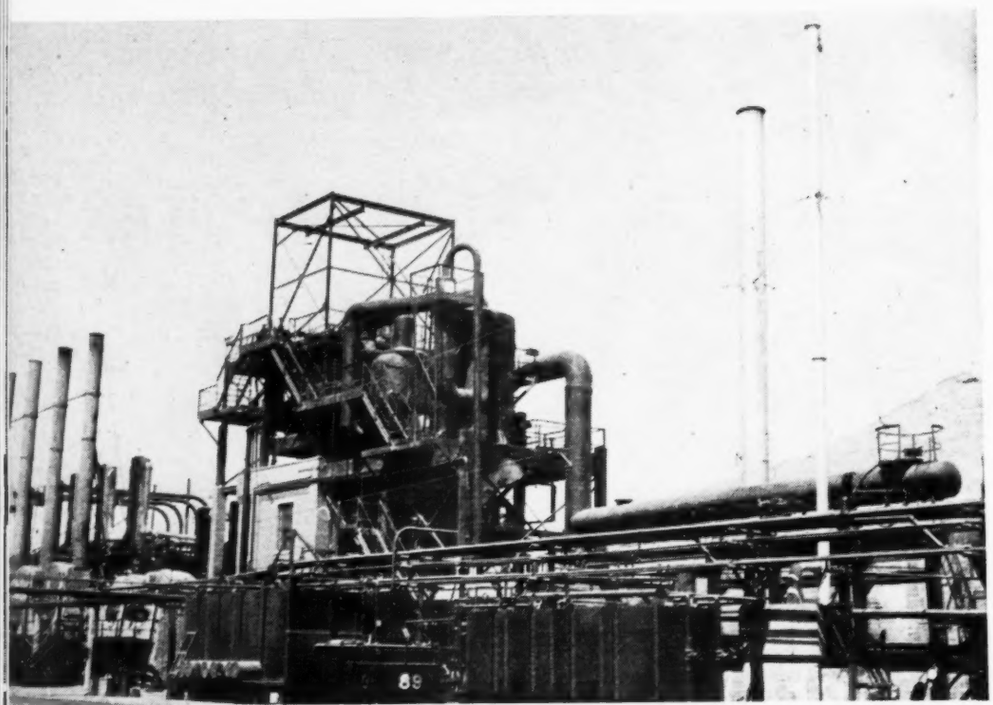
main pump station, the water to which is delivered from the river by electric-driven pumps. The water passes through filter and sedimentation beds and is treated with alum and lime. It also is chlorinated before being pumped through a 10-in. line and pure water to the amount of 1,300,000 gal. daily is delivered to the various operations.

Shipping Facilities

The harbor at Talara will accommodate the largest vessels and all equipment and supplies for International Petroleum Company operations are brought in through this port. Two moles have been built and packaged products are loaded aboard ship from Mole No. 1 and refined products in bulk from Mole No. 2. A loading speed of 4000 bbl. a hour is guaranteed from this latter mole.

Refined products are sent to all Central and South American countries (except Colombia and Venezuela) and to Europe, the case trade going to the west coast of South America and to Central America. The company makes its own 5-gal. cans and cases and is able to manufacture them at a speed of 900 cases (1800 cans) an hour. It also makes it own light-steel, 18-gauge drums. In Peru, International does its own marketing, having bulk facilities on the coast, but in other countries it sells to distributors.

Crude oil is loaded in tankers through a 12-in. sea line 6000 ft. in length. This line is buried in the sand, having two 8-in. hoses rising from its end and the oil is pumped through the line with power supplied by two 65-hp. Diesel engines. The high cold test and light cold test oils are kept separated. Crude exports go all over the world, with a considerable portion to the refineries in Canada, to Europe, and the Argentine.



Above: Vacuum lube plant and old lube stills, Talara refinery

constructed on the river about 25 miles south of Negritos, but in 1927 an enlarged plant was built on higher ground to the north at Portachuelo. Here now is the treating plant and

Radial-cone pressure storage tanks on left with cane covered tank to be seen on right, Talara tank farm

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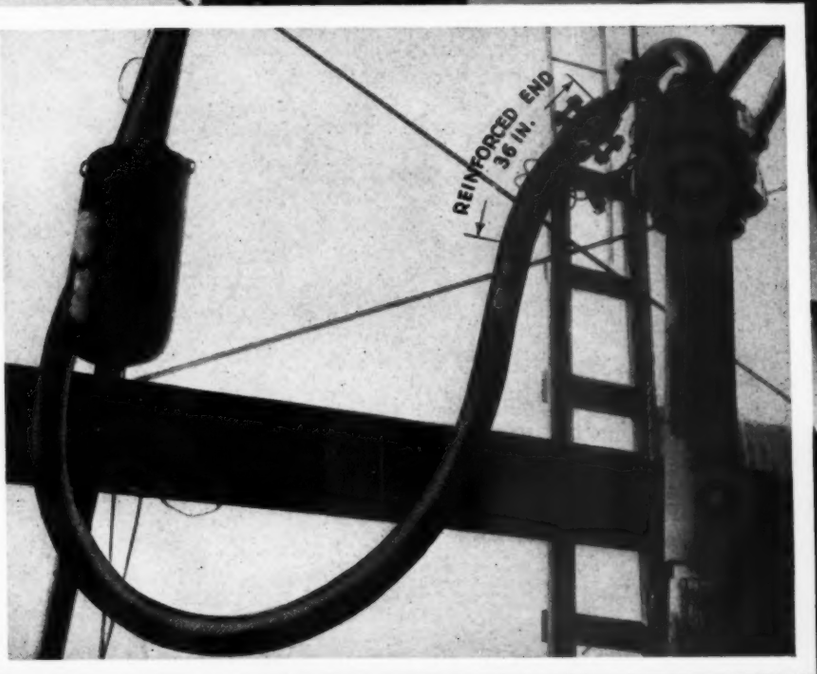


Ask the U. S. representative about U. S. SPECIAL OILFIELD STEAM HOSE, 3' i.d., for flexible connections from steam line to drilling engines and pumps. It saves rigging-up time and eliminates vibration.

Lomitos section of Negritos, Peru. This area of the International Petroleum Company's Negritos field was drilled entirely with cable tools

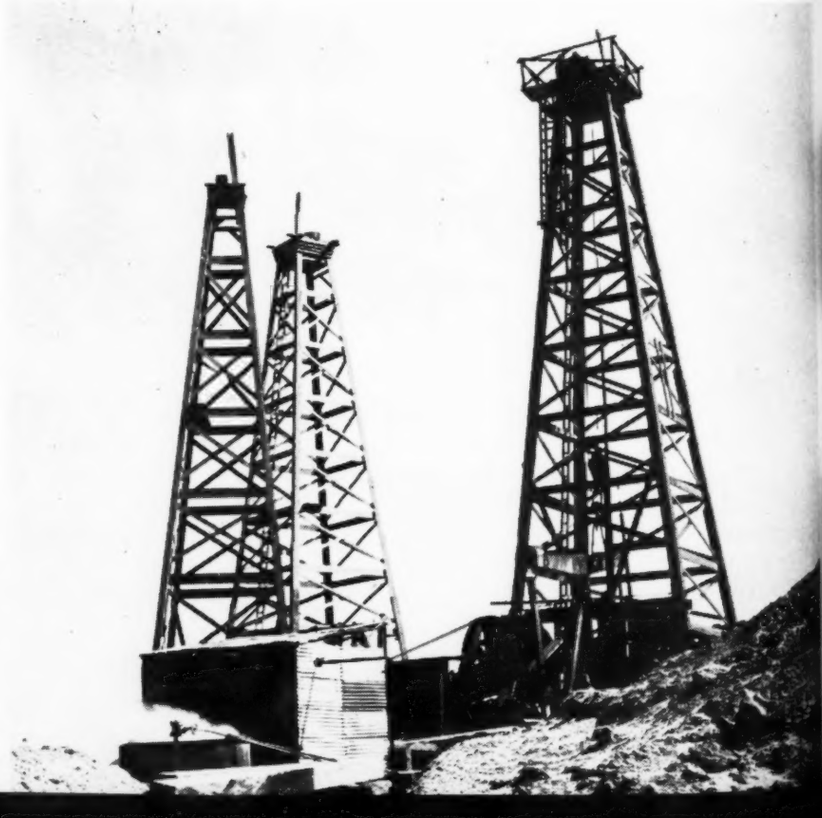
Negritos District One of Important Oil-Producing Areas of Peru

From 1840 wells the daily crude production is 40,000 bbl.—Average depth of most wells is approximately 2000 ft.—Drilling and production practices

THE name "Negritos District" is given here to designate the territory covered by the La Brea y Parinas Estate, which is operated by the International Petroleum Company, Ltd. Since 1899 nearly 3000 wells have been drilled in this district with production developed up to the present time in the areas shown in Fig. 1. The oil all comes from the Eocene and the deepest test, which went to 6400 ft., remained so far as is known, in the Tertiary. In a well drilled approximately 40 miles southeast of Negritos, however, the Cretaceous was penetrated. The deepest producing well at the present time is 4750 ft. in depth, but the depth range for the district is from 300 ft. to 4750 ft., the average being slightly less than 2000 feet.

A big uplift in the Tertiary has left the formations badly faulted and broken with the result that there is a number of blocks that are in a large part concealed. The sands vary and range from fine to pebbly. Some are loose and coarse; some are hard and very fine. The thickness of a sand may vary from 10 ft. to 100 ft.; or 300 ft. might be found in one location, and only 30 ft. in the one adjacent. The formations are exceedingly lenticular in sands and in sand series. The total thickness of sand in this district ranges from a few feet to more than 1000 ft., but it probably averages about 300 feet.

At the top of the structure the upper horizons are eroded away, only the oldest being present. As the district is made up of a number of pools or blocks it is naturally desirable to determine the limits of a productive area or to find out, in fact, just where production can be obtained. Surface indications are of little or no help and the unknown subsurface conditions as they have been discovered may be entirely different from what might be expected from the indications supplied by the data available. At the present time geophysics is being used to aid in the determination of prospective areas and of favorable locations in areas now being developed. There probably are more productive areas than have yet been picked up and it is hoped that geophysics will aid in their discovery.



Drilling the second well on a two-well cable-tool location, Lomitos area of the Negritos District. The production derrick to the rear is ready to be moved on to the well when it is completed

Fig. 102—HERCULES Type B "Overhead-Packed" Forged Steel Casing Head with Mandrel. 7000 lbs. test.

Fig. 101—HERCULES Type B "Overhead-Packed" Forged Steel Casing Head with Slips. 7000 lbs. test. Also made in Cast Steel.

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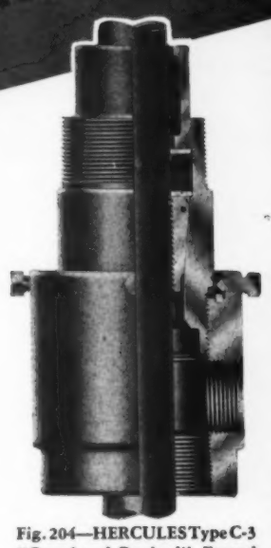

Fig. 204—HERCULES Type C-3 "Overhead-Packed" Forged Steel Tubing Head with Slips. Also furnished with mandrel. 5000 lbs. test.

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Fig. 215—HERCULES Combination Globe-Relief Valve. Eliminates paraffin in tubing or flow lines by maintaining constant pressure in tubing and preventing periodic flow.

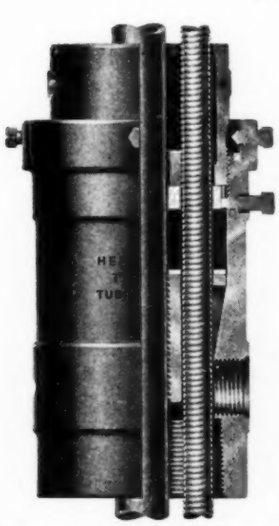

Fig. 210 — HERCULES Type R "Overhead-Packed" Forged Steel Tubing Head with Slips. Has conduit for cable for Reda pump. Oil saver top. 2000 lbs. test.

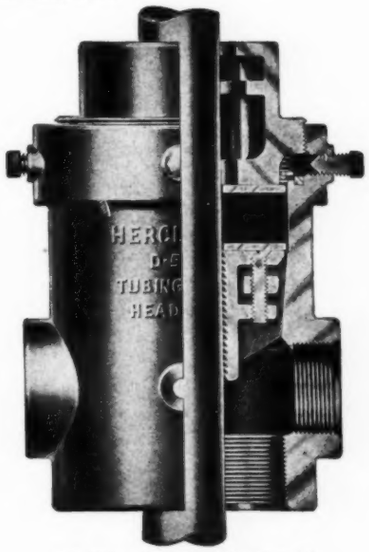

Fig. 209 — HERCULES Type D-5 "Overhead-Packed" Cast Steel Tubing Head with Slips. Full opening. 2000 lbs. test.

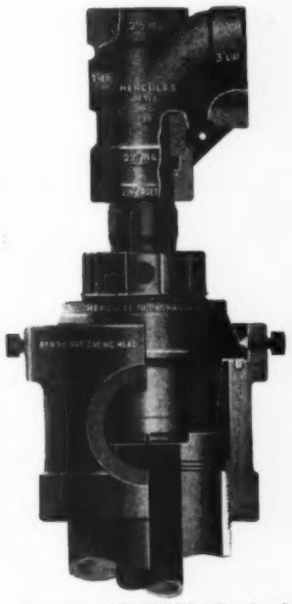

Fig. 219—HERCULES "Overhead-Packed" Tubing Hanger with Slips, sitting in Berry casing head, with HERCULES Upset Pumping and Flowing Tee. The standard pumping well hook-up.

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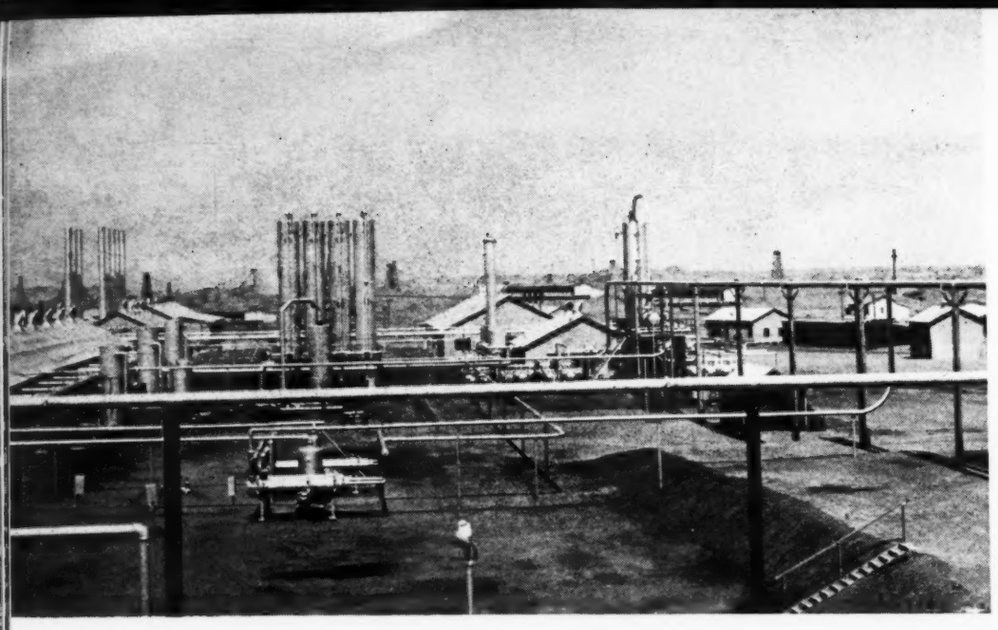

Absorbers and distillation unit, Lomitos plant

The productive sands are known as the Verdun, the Lomitos, the Parinas, and the Salinas. Sometimes there is a definite separation between sands but at other times there is not. The Verdun, however, always is distinct. The gravity of the oil depends on depth and ranges from 18 deg. A.P.I. to 50 deg. A.P.I., the average being about 40 deg. A.P.I.

Both high cold-test and low cold-test oil is produced but the high cold-test never is found above 1000 ft. and the low cold-test never below 2000 feet. High and low cold-test oils, however, may come from the same sand; shallow wells in a sand may strike a cold-test oil while deeper wells in the same may produce a high cold test. The high and low cold-test oils always are kept separate.

Drilling

Until 1934 all wells in the Negritos district were drilled with cable tools. At that time the rotary was introduced and the deeper wells are now being put down with rotary tools. Cable-tools, however, still are widely used and for depths of less than 1000 ft., portable cable-tool machines are employed. Steam provides the power for drilling, a long belt connecting the steam engine and drilling machine. Gasoline engines are used in moving the equipment from place to place.

All four sands are drilled by cable tools but only the two lower—the Parinas and Salinas—are produced from wells drilled by rotary equipment. Bits used in rotary drilling are fish-tail, drag, and 3-cone rock bits. The mud is made with fresh water from surface clay. It is seldom heavier than 85 lb. per cu. ft. and weight materials are not used to any great extent. The mud is passed through vibrating screens before entering the settling ditch.

A generalized casing program for rotary wells drilled in the Negritos district is shown in Fig. 2. Upper sands are not designated but no danger from water is encountered as the 10-in. surface string, cemented from bottom to top, shuts off all water. A 6⅝-in. oil string is cemented on top of the sand, which is picked up at depths ranging from 2000 to 4000 feet. A 5-in. perforated liner is hung in the oil string, after which tubing is run to the best depth for production.

At many locations twin cable-tool wells are drilled and used to produce from different zones. As shown in accompanying illustrations, a production derrick is made ready to be moved over to the well as soon as it is completed.

In drilling wells with cable tools it is hard to plan the casing program in advance, although after an area is partially developed the size of casing can be determined to some extent. A surface string always is cemented at from 200 to 300 ft.; but after that a string usually has to be carried to the top of the oil sand as a protection against caving. Mud is used in the hole where gas pressure is expected. After reaching the sand, the protection string is pulled out and an oil string set. The well is then drilled-in and perforated liner run. After production is bailed in, 2-in. or 3-in. tubing is run and the well connected up.

All wells are cemented with equipment transported to the location on narrow-gauge railway spurs laid to each well from a main line serving the area as soon as the location is made. All heavy equipment and materials are taken to the well by this means, which has been found to meet conditions better than the use of roads.

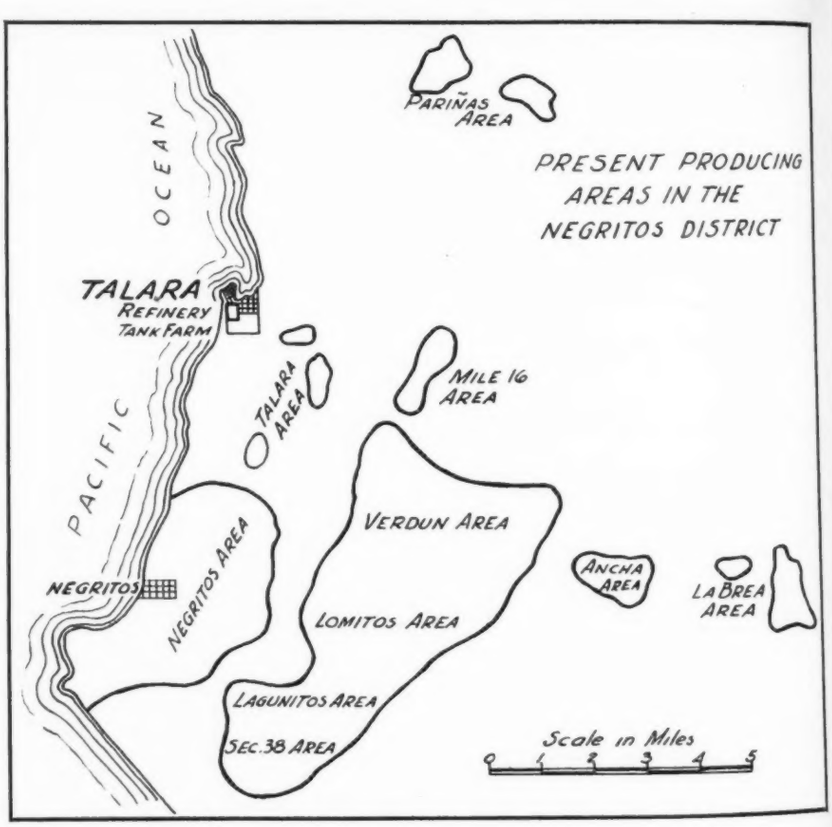

Fig. 1. Fields in the Negritos District

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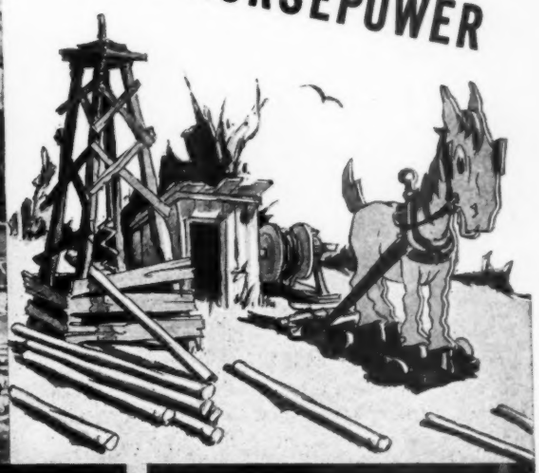
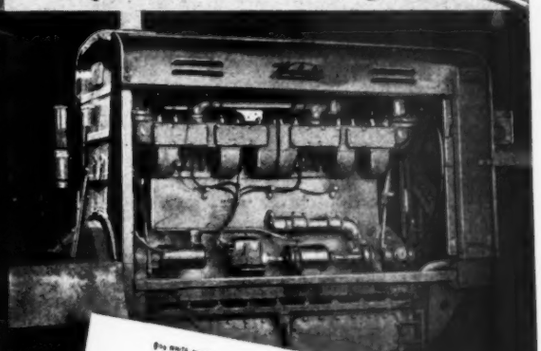


Cable Tool Drilling Demands REAL HORSEPOWER



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Cowden & Skinner
By Frank H Skinner
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When an engine is driving a cable tool drilling rig, you can soon find out whether the horsepower shown on its rating curve is paper horsepower or *real horsepower.*

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Mounted on an O.C.S. reverse counter shaft, this engine has drilled 9000 feet of hole—without one minute of delay. Casing sizes were 15½, 12½, 8, and 6⅝ inches. That means just about the entire range of power requirements, from light to heavy loads. And the engine had to idle a great deal of the time. Tough going for any type of oil engine—but a Waukesha-Hesselman can take it. Its economy matches its reliability—80 gallons of fuel per 24 hr. day, at 6½ cents a gallon delivered to the well.

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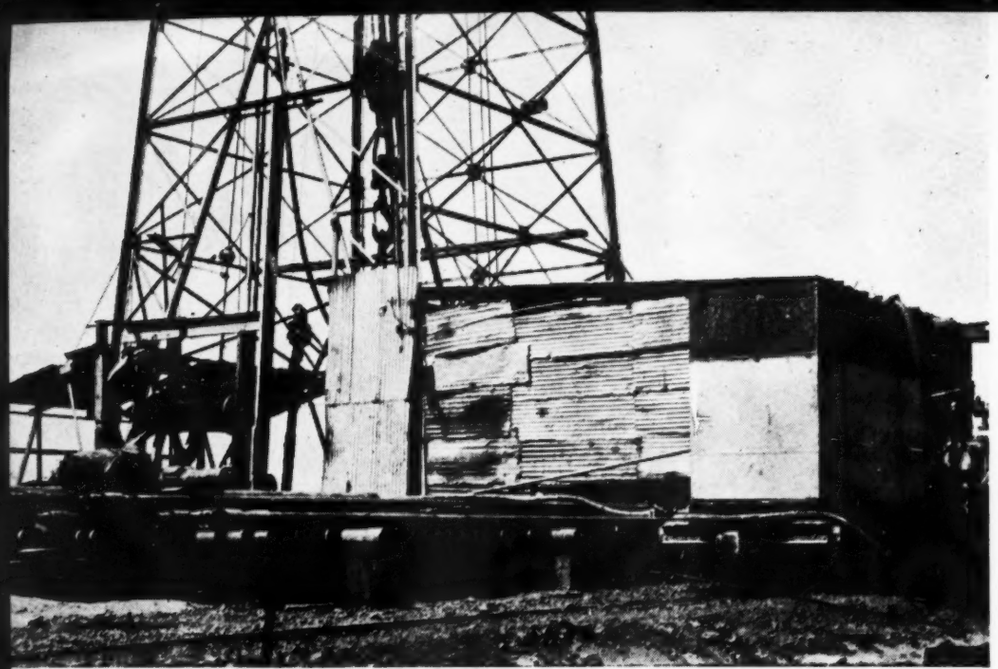


Cementing equipment is brought to a well on a narrow-gauge railway and is here shown standing ready to cement a rotary well. Note the pipe rack laid partly on a sand dune

Oil Production and Utilization of Gas

Production from the Negritos district is now averaging more than 40,000 bbl. daily from 1840 wells. Approximately 65 of these are flowing 13 are on gas-lift, and approximately 1691 are pumped continuously. All production is clean oil. On completion some wells flow as much as 1500 bbl. daily from depths of only 2000 feet. Though most of the flowing wells are completed in the Parinas there are some wells flowing from all the sands except the Verdun.

The gas/oil ratio from the flowing wells averages 350 cu. ft. and the average for the entire field is less than 1000. Bottom-hole pressures are as high as 2700 lb. per sq. inch. Back-pressure is held on flowing wells and every means possible is taken to provide efficient production and high ultimate yield. Production is regulated by gas/oil ratio, bottom-hole pressure, and other individual well conditions.

Oil from each well is measured individually each week and its production carefully watched and controlled. Deepening and scientific repair work have aided in maintaining well production and prolonging the life of many of the older wells during recent years.

Careful attention is given to the design of jerk lines from wells to central pumping stations or "catilinas." Several of these lines are greater than 2000 ft. in length; and for a long, flat line a catenary sag is computed carefully and put into the line. This has been found to reduce friction, cause less wear and tear on equipment, and eliminate loss of stroke. The powers are situated so as to handle the greatest number of wells. By keeping a balance on the power, as many as 38 wells are pumped from one catalina. In addition to the central powers, there are approximately 20 individual pumping units in service but each of these is handling two or three additional wells.

No gas is wasted in any operations in the Negritos district. From gathering stations, where it is taken off by low-pressure separation, the gas goes

Pump station in the Negritos District pumping oil to Talara

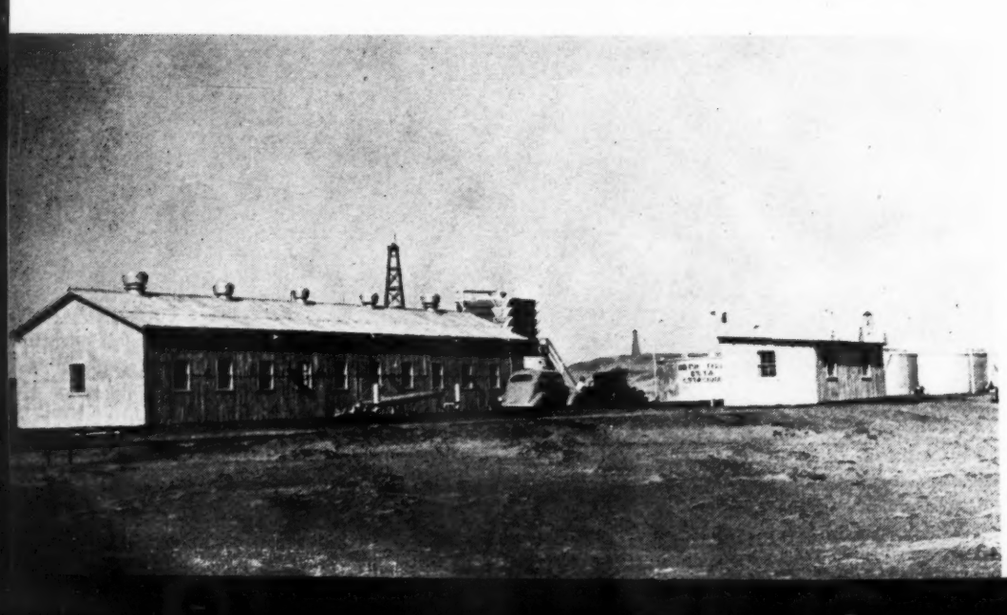
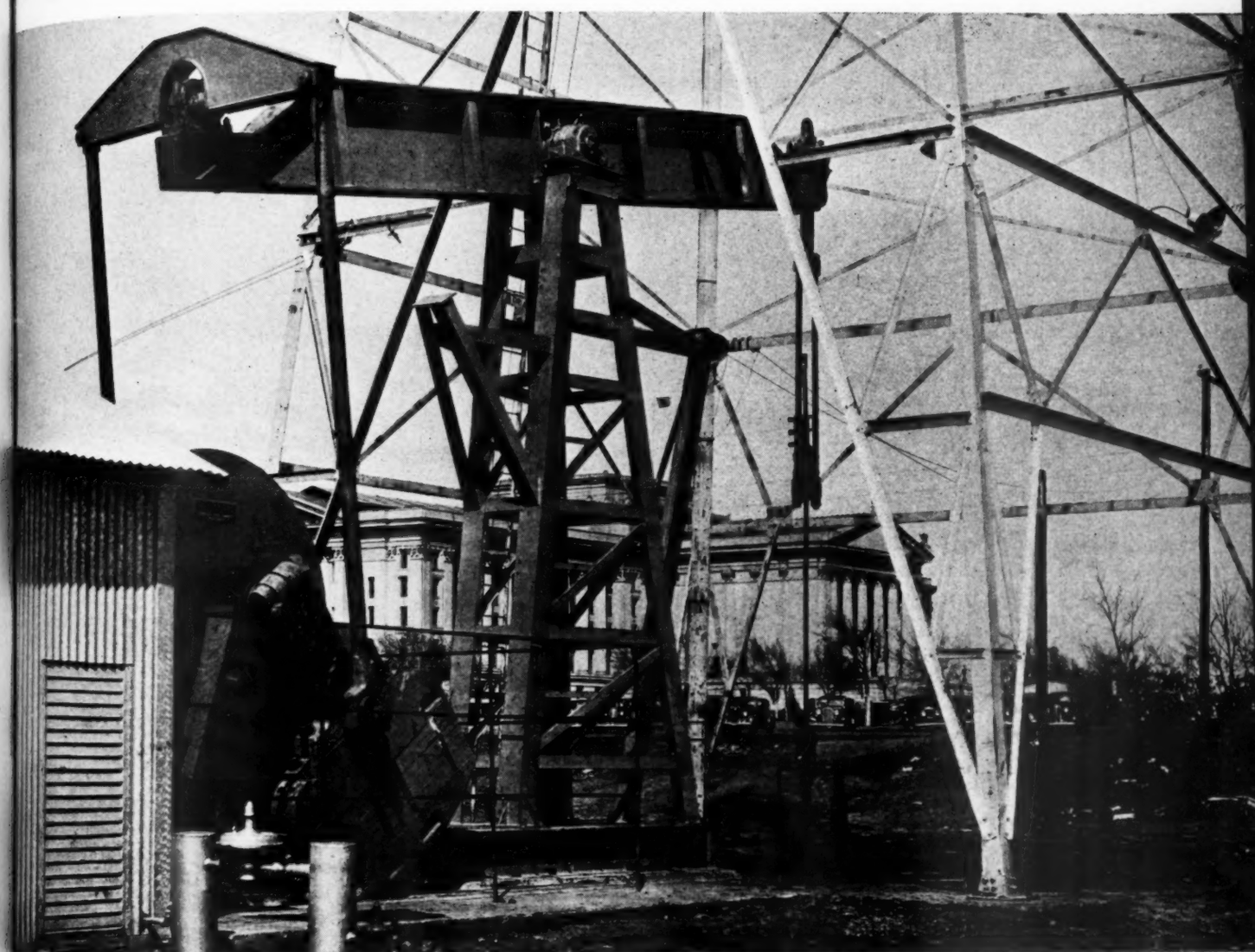


Fig. 2. Typical casing program for rotary wells in the Negritos District

Capital Machines for Capitol Wells



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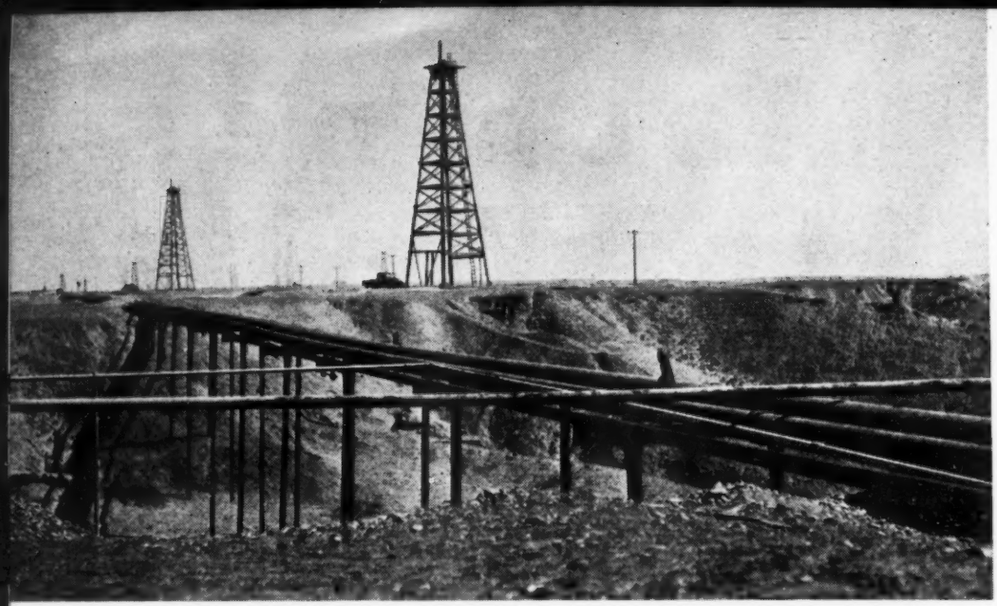
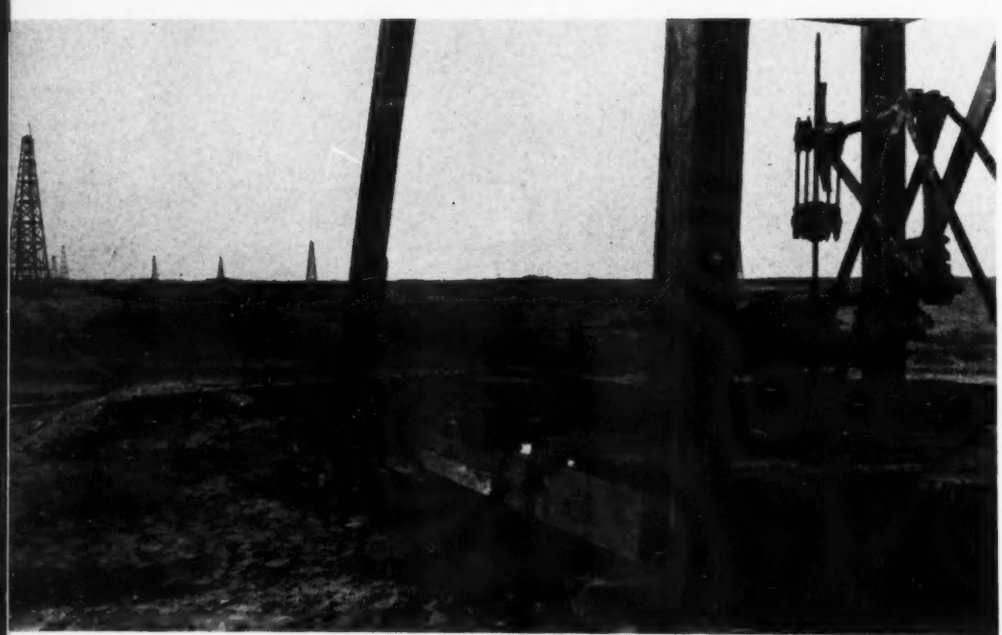


Here can be seen how lines are laid in the Negritos District, all above ground. They are shown crossing a gully. The center 10-in. and 12-in. lines are vacuum lines from a gathering station to a gasoline plant; the outside 4-in. and 5-in. lines are mineral seal oil circulating lines, one carrying lean oil and the other fat oil; the 8-in. center line carries field fuel gas; and the 2-in. line is for high-pressure gas to an input well for repressuring



Sag in lines is carefully computed for all wells being pumped from central power. This is a well in Negritos field

to the gas plant and is stripped by absorption. The residue is used for fuel and for repressuring.

Approximately 60 percent of the gas goes back into the sand for repressuring. All except a few of the old areas are repressured but some formations do not react so favorably as others because of a difference in permeability. In planning repressuring operations the best geological data and producing characteristics of wells are procured and all factors, such as bottom-hole pressure, that might influence the repressuring are taken into account. All input gas is injected at a pressure less than 1000 lb. per sq. inch. The main feature of the operation is control of gas/oil ratios.

Input wells are selected carefully and kept permanently as such when conditions do not change. Each producing area is repressured and operated as a unit; yet the general repressuring operation of the entire district is centrally controlled so that flexibility in operation can procure the greatest efficiency in cooperation with other operations.

For the manufacture of natural gasoline from the gas produced in the district, three plants are equipped with both absorbers and distillation units. Mineral seal oil, however, is piped from these plants to compressor stations in the fields where absorbers are situated. After passing through the absorbers and stripping the gas at the field stations, the rich oil is returned to the gasoline plants for distillation with the rich oil from the plants' own absorbers. All crude gasoline, however, is sent to the central gasoline plant at Lomitos for stabilization. This system of consolidating the distillation units in three plants and of stabilizing at one plant the entire product from the field has been found efficient and economical.

The Lomitos plant has 32 compressor units. Of these 15 are on vacuum, the others put gas into the fuel and repressuring systems. The gas comes in at 14 in. vacuum and goes through absorbers at a pressure of 45 lb. per sq. inch. Gas for repressuring is compressed to a pressure anywhere between 250 and 1000 lb. per sq. inch. The Lomitos plant is equipped with four absorbers and two stabilizers but takes crude gasoline from five other plants for stabilization. Gasoline can be processed at a pressure of from 12 to 26 lb. with propane and butane separation. Bottled butane is used along the coast down as far as Lima. All products are pumped to the refinery at Talara through one 4-in. and one 3-in. line at an input pressure of 200 lb. per sq. inch.

There is a complete laboratory at Lomitos for analyzing gas, gasoline, oil, and water. Each plant has a small laboratory for routine testing but this is a general laboratory for all gasoline department work.

Electricity is generated at the Lomitos and Verdun plants for all pumps and for lighting at plants and in the field in the vicinity of the plants. The rest of the power used in the field comes from the power station in Talara.

Except in very few cases, stations pumping crude from the field are situated so that the oil gravitates to them from the field batteries at gathering stations. Gas engines supply power for pumping through main lines laid above ground. Tanks for checking oil gauges are situated at the top of a hill above Talara, whence the oil gravitates to storage in the tank farm.

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The Lobitos District

Lying north of Talara, the productive territories in this district are known generally as the Lobitos and Northern areas — Drilling methods, production, gas utilization, and shipping facilities

THE Lobitos District lies north of Talara and is operated by Compania Petrolera Lobitos. The productive territories in this district are known generally as the Lobitos and Northern areas but the Northern division itself consists of the El Alto area and the Coastal or Restine area. Wells around Cabo Blanco may be considered as an individual area or as a part of the Coastal area. The general location of this district is indicated in Fig. 1, of article entitled "Production and Refining Methods in Peru are Highly Developed," and the relative positions of the different areas are shown in Fig. 1, this article. Of considerable interest is the topography of the El Alto area, which is on the highlands rising to nearly 1000 ft. directly above the ocean and which is broken in the interior by deep canyons. Several wells producing in this area do not penetrate to sea level and thus are completed above the surface locations of wells drilled in the Coastal area.

At left: The Restine area along the coast, Lobitos District

Excellent roads have been built throughout the district and considerable engineering skill is demonstrated in their construction along the cliffs rising from the ocean and into the vast canyons. Narrow-gauge railways provide transportation for heavy materials and equipment to well locations as in the Negritos district and a similar network of tracks covers all the areas. A wider gauge main railway line connects the camps at Lobitos and El Alto, which are the operating headquarters for the Lobitos and Northern areas, respectively.

Though the Lobitos is the oldest area and was developed first, the main shops are now at El Alto. These shops are complete in every detail and even the casing used in the wells is threaded there. An inserted-joint type of casing connection is employed and the pipe joints received at the shops are expanded at one end for inside threading and contracted at the other end for outside threading. The shops also are equipped for forging. In the machine shops a considerable amount of equipment is made especially to meet the operating conditions encountered in the district. Such things as the catalinas (central powers) are of the company's own design and are made up at El Alto. All work is done by Peruvians who hold positions from superintendents down.

Sea water is used for operations in the field; but plants for distillation of the water necessary for drinking, laundry, and other fresh-water requirements are maintained at Lobitos and El Alto. The Northern area is completely electrified and the only boilers used here are for distillation and at the laundry. In the Lobitos District, some steam engines and gas engines are used. The distillation plant at Lobitos is built on the shore near the ship-loading mole and coils from this plant are run out on the pier for cooling with sea water.

The power plant supplying electric current to all Northern area operations is just off shore in the Restine area. It consists of two 750-hp. engines driving 835-kva. generators and four 200-hp. engines driving 174-kva. generators. The 3300-volt current produced is stepped up to 11,000 volts for transmission.

Drilling Methods

Oil in the various areas is found in sheared sandstone. The reservoirs are formed by submarine land slips that occurred soon after deposition. The accumulation generally has been around the axes of much-faulted anticlines.

Gasoline plant at Lobitos

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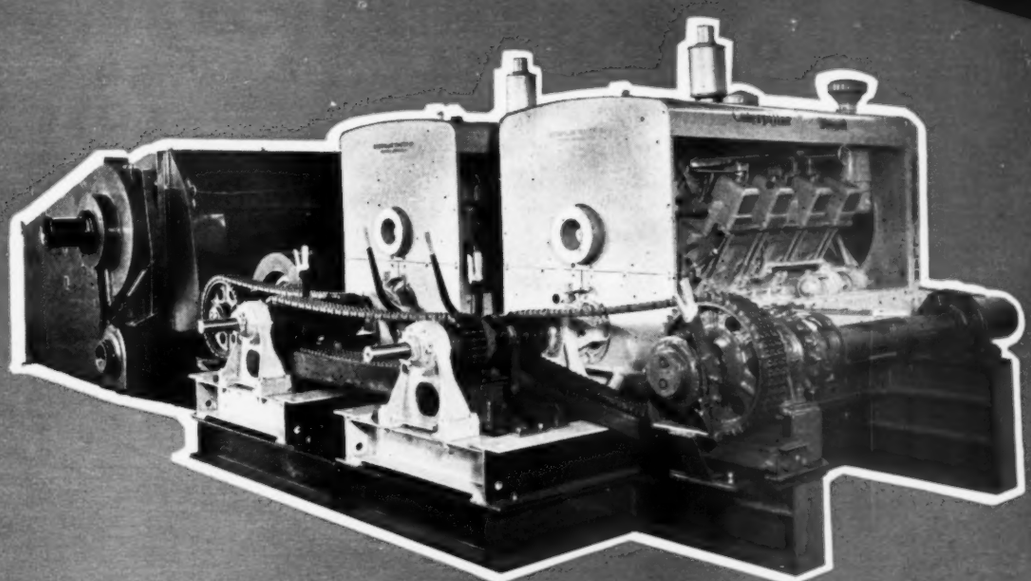

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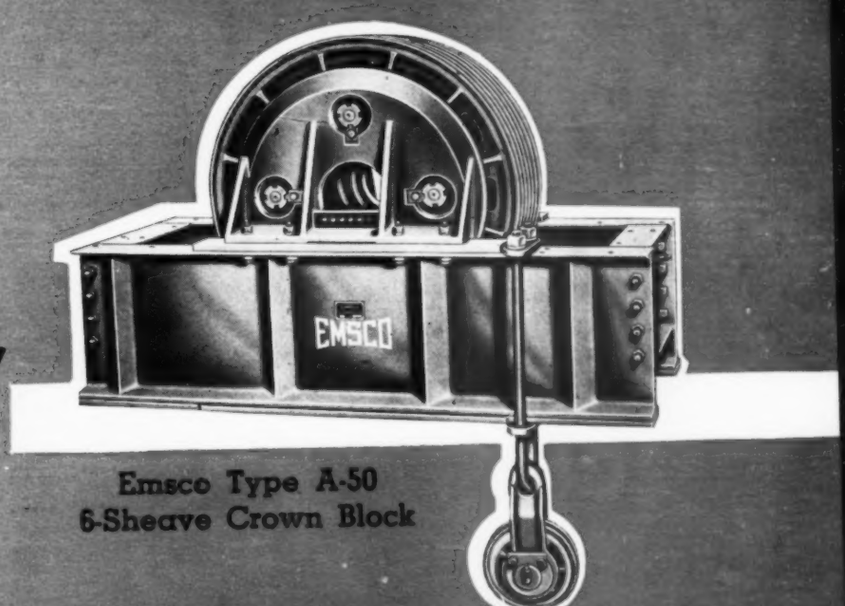

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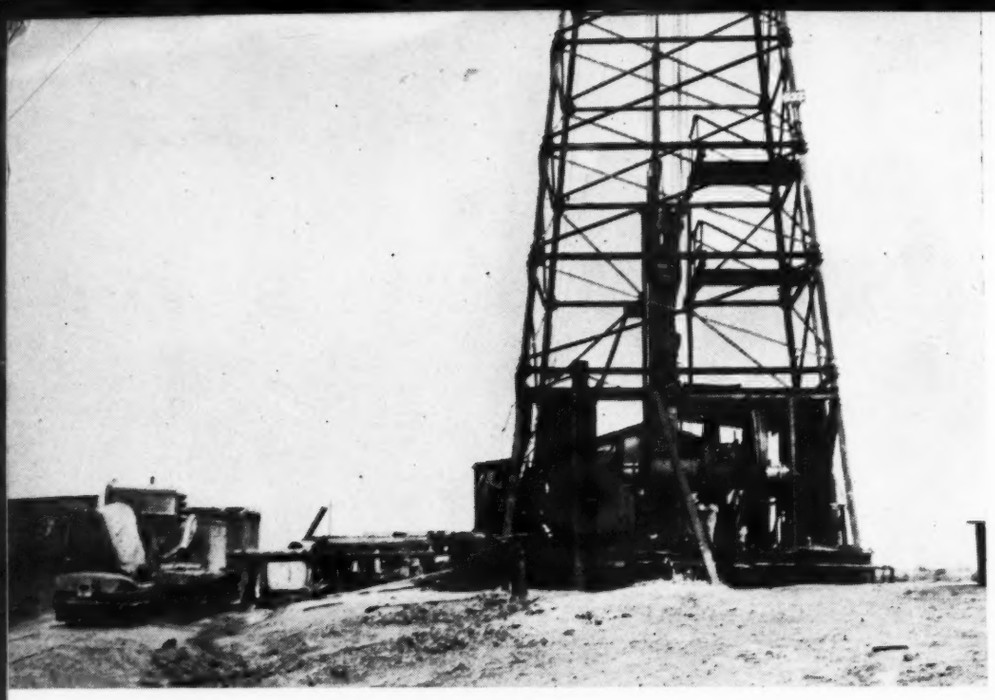


An electrically-drilled cable-tool well standing cemented. The cementing equipment is on the narrow-gauge track built to the well. Lobitos area of Lobitos District

(Continued from page 154)

There are seven main horizons and all are of Eocene age. The highest is found from the surface of the ground to a depth of 1700 ft., and the lowest at depths from 3500 to 6500 feet. The sands are tight, but vary over the district, and are faulted.

As in the Negritos District, it is impossible to predict in many places what subsurface conditions will be encountered. For example, two wells were drilled within 32 ft. of each other. In one flush production was found at 900 ft., but in the other the sand was missing. In another well the same sand was picked up twice. There was no doubt about this, as the sand was one that is positively identified and is different from any other sand in the district.

All wells are drilled with cable tools and no coring is done. The driller, however, collects a sample every five ft. of hole and lays this on a board for the geologist to inspect. The geologist examines the samples thus provided and, if he desires, takes them to the laboratory for paleontological analysis. It is impossible to make a definite prediction regarding cementing points or the location of the sand, even in areas where conditions are thought to be known.

The first well in the district was completed in 1904 as a 50-bbl. a day producer at a depth of 1627 feet. This was in the Lobitos area, the first to be developed and from which the oil originally was produced from shallow depths. A deeper test later was put down and now almost all wells are drilled to 4000 ft., the deep wells being completed between 4000 and 4500 feet. The deepest well was drilled to 6586 ft. in 1931, and has been flowing steadily since.

The wells in the Northern area all are comparatively shallow, the average depth being 1500 ft., the deepest to date being only 2500 feet. All wells are drilled with electric power. Considerable activity is now being displayed in the eastern portion of the El Alto area and deeper wells may be drilled there.

The areas outlined in Fig. 1 are not completely developed and there is considerable drilling yet to be done. There probably are productive areas in the district yet to be discovered; but considerable time and money will have to be spent before they can be found. The uncertainty of the sands, even in the areas now being drilled, offers plenty of problems at the present time. There are 12 rigs running at El Alto and six at Lobitos.

As already mentioned, all drilling in the Lobitos District is done with cable

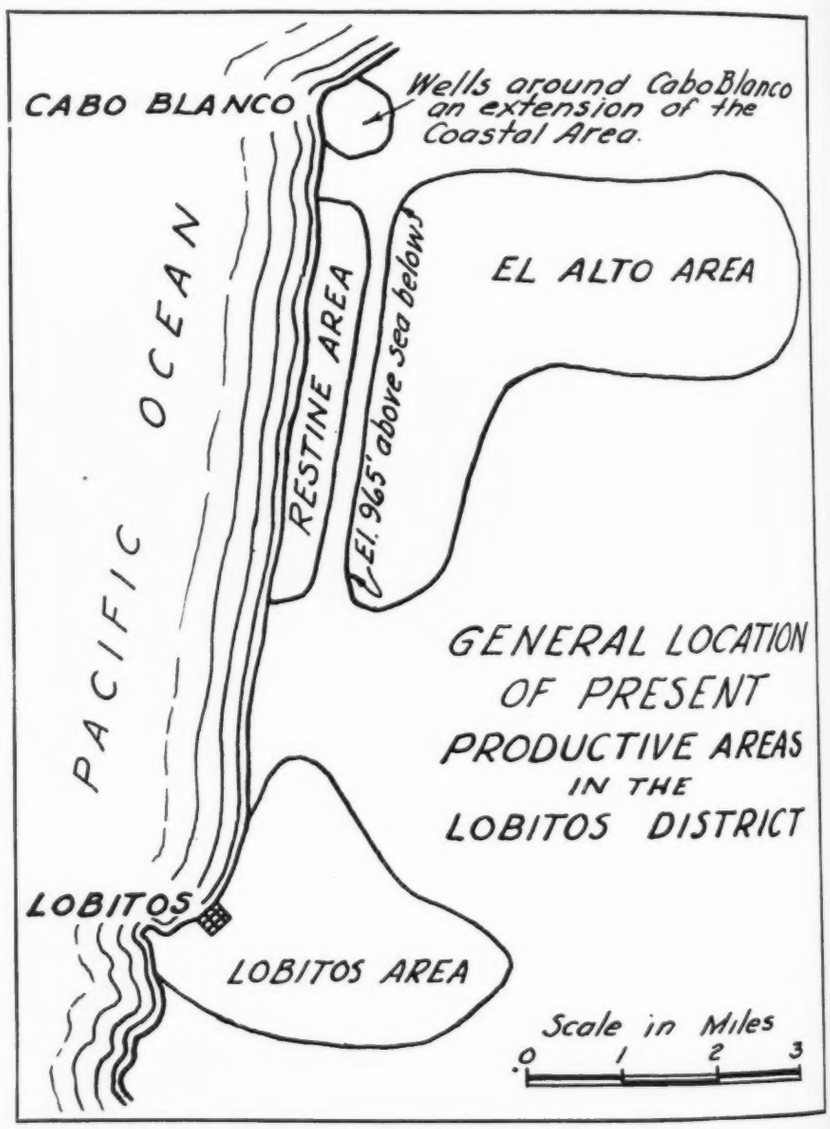

CABO BLANCO
Wells around Cabo Blanco an extension of the Coastal Area.
PACIFIC OCEAN
RESTINE AREA
El. 965' above sea level
EL ALTO AREA
GENERAL LOCATION OF PRESENT PRODUCTIVE AREAS IN THE LOBITOS DISTRICT
LOBITOS
LOBITOS AREA
Scale in Miles
0 1 2 3

Fig. 1. Productive areas, Lobitos District

A Catilina (central pumping station) handling 36 wells, Lobitos field

tools. In the Lobitos area on the south, where steam is employed in drilling some of the wells, ocean water is used in the boilers. The exhaust steam from the engine is run through coils to condense it and the fresh water so made is put back into boilers to keep down the salt content. Water used in the hole is taken from the ocean.

Standard bits are used for drilling but an eccentric type also is employed to a considerable extent to save underreaming. Conductor pipe is cemented in all wells and ranges in size from 19-in. to 22-in. casing. The surface string for shallow wells is either 10-in. or 12-in. casing and is set at from 500 to 800 feet. In deep wells the surface string is 14-in. or 15½-in. and sometimes is run to 1500 feet. After setting this string, the well is drilled as far as possible with open hole; when the hole begins to cave a string of casing is run in and carried during drilling.

It is the aim to cement just above the oil sand, then drill in and run the liner. Shallow wells generally are finished with 9-in. casing, into which an 8-in. liner is run. Efforts are always made to complete the deeper wells with 5-in. or 6-in. casing. Deep tests are usually completed with 4-in. casing.

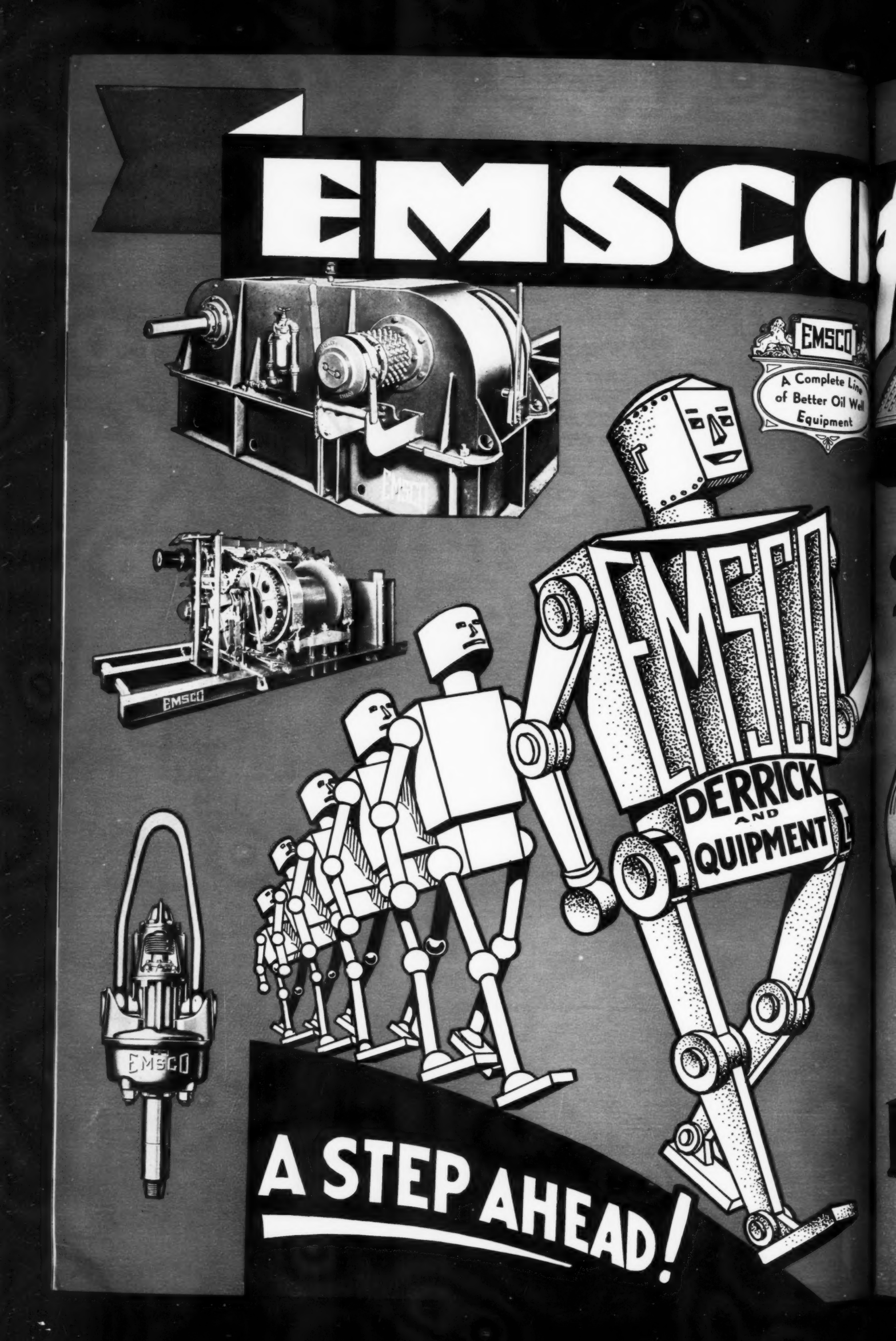
Cabo Blanco. Sea lines go out from here to load crude from the northern areas of Lobitos district

Production and Gas Utilization

Production from the entire Lobitos District is approximately 6700 bbl. daily, more than 4000 bbl. of which comes from the El Alto area at the present time. This is from 450 wells in the Northern area and 220 in the Lobitos area; approximately one-fourth of all these wells flow naturally. Both high cold-test oil and low cold-test oil are produced, the gravity of the former being about 37 deg. A.P.I., and that of the latter 35 deg. A.P.I. No high pressures are encountered. The gas/oil ratio in the Northern area

(Continued on page 162)

The water condensing plant at Lobitos. Coils are built on the mole for cooling with sea water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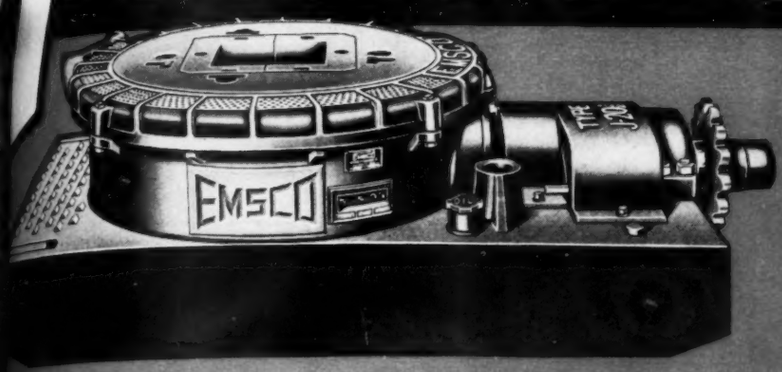

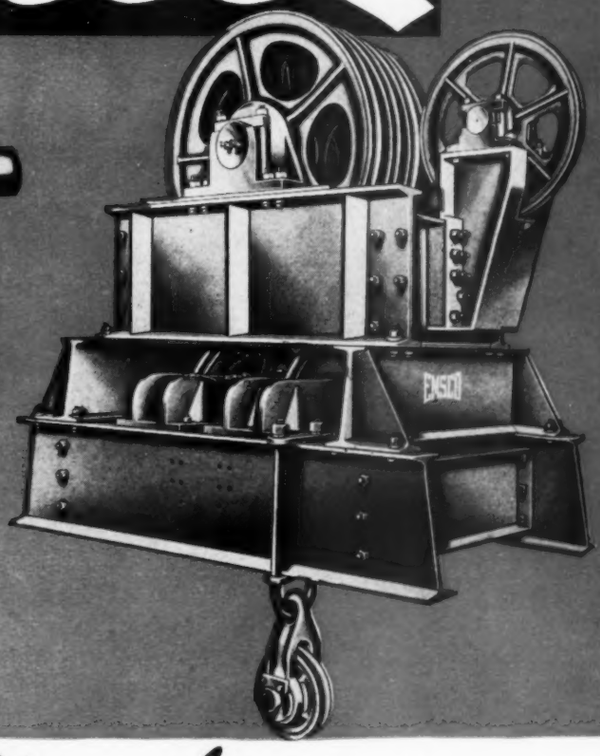

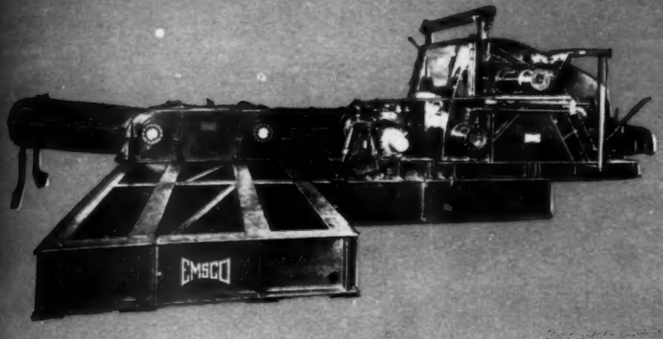

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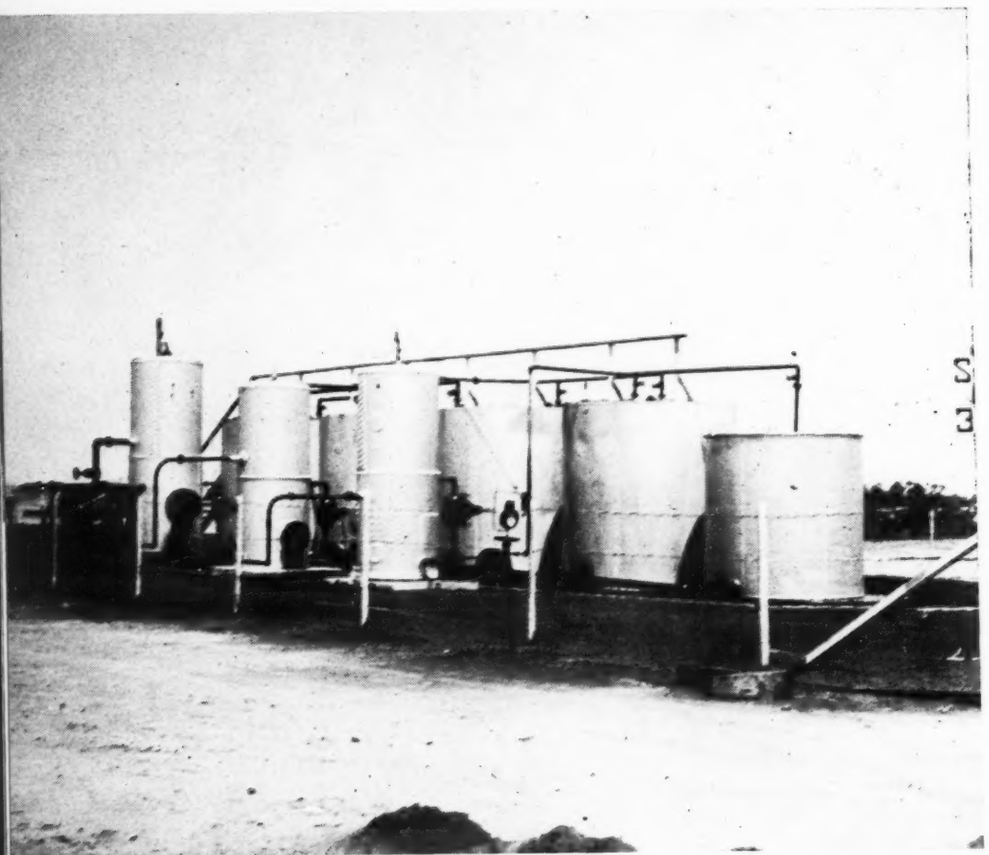


Gathering station, El Alto area of Lobitos District. Separators are on the ground since oil is under pressure in this field and the pressure forces oil up into tanks

(Continued from page 159)

ranges from 200 to 1200 cu. ft. per bbl.; that in the Lobitos area is approximately 2500 cu. ft. per barrel.

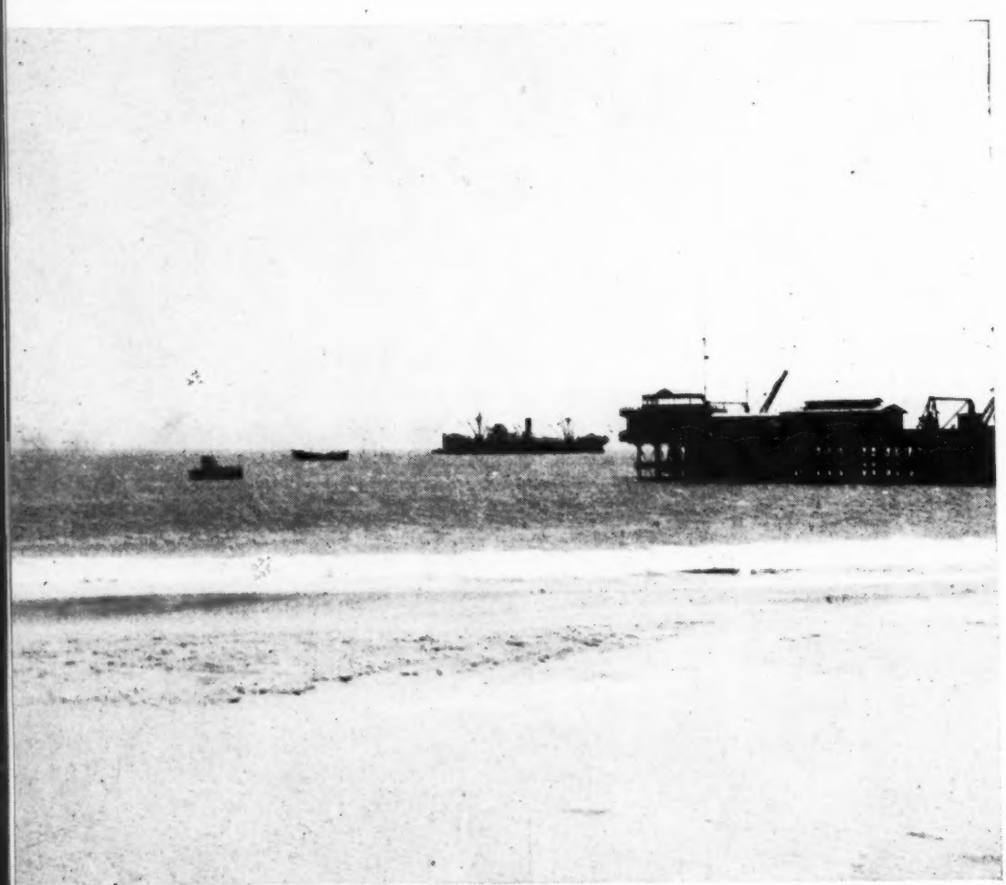
Some of the wells are on gas-lift and most of these are flowed intermittently with a device patented by an employee of the company. Central powers, or "catilinas," are used generally for the pumping wells, one power alone handling 36 wells. Most of the separators at the gathering stations in the El Alto area are placed on the ground. As the oil is produced under pressure in this field, there is sufficient pressure in the separators to flow the oil into the tanks.

There are compressor stations in each area and an absorption plant at Lobitos. Gas going to the absorption plant is taken off the separator and into the plant at five in. vacuum. It passes through the absorbers at a pressure of 30 lb. per sq. in., and, after stripping, goes into the fuel line or to compressors. At the compressors the pressure of the gas is boosted for use in repressuring operations in the Lobitos area. Input wells for repressuring usually are kept as such for this purpose but sometimes they are changed when different locations for gas injection are deemed advisable.

Shipping Facilities

Crude oil from the entire Lobitos District goes to various destinations; a complete supply is sent to the company's refinery at Manchester, England. The natural gasoline manufactured at the absorption plant is piped to the International Petroleum Company's refinery at Talara.

Oil from the Lobitos area is shipped from Lobitos and that from the Northern area from Cabo Blanco. At Lobitos both the high cold-test and the low cold-test oil is pumped to tankers through sea lines extending 5000 ft. into the Pacific Ocean. One line is 10 in. and the other 9 in. in diameter. At Cabo Blanco, the high cold-test oil is pumped through the sea line but the low cold-test oil flows by gravity through its line to the ships taking it as cargo. Both lines here are 10 in. in diameter and are 1300 ft. long.



Sea-going freighter unloading casing. The end of mole can be seen on extreme right, Lobitos

Petroleum Development in ◥ Argentina ◤

Drilling and development operations in the Argentine Republic under Government control show great progress

A GROUP of inhabitants from Comodoro Rivadavia (National Territory of Chubut), who were almost completely without any sources of drinking water, requested the National authorities to send them a drilling machine whereby they might remedy their serious plight.

The request went to the Department of Agriculture, and this department then directed the Mining, Geology, and Hydrology Division (today known as the Department of Mining and Geology) to proceed to explore the land and to drill for water. For this purpose, in 1903, light rotary drilling equipment was installed.

Drilling was begun in the town of Comodoro Rivadavia, but, for some technical reasons, it was abandoned at a depth of 175 meters (574 ft.).

At the beginning of 1907, the same department sent a Fauck steam drilling rig, with a capacity for drilling to a depth of 500 meters (1640 ft.), and equipped with injector. This rig was installed approximately three kilometers from Comodoro Rivadavia, and drilling was begun on March 24, 1907.

The work proceeded despite the many handicaps arising from adverse weather conditions on a land theretofore unexplored, and on November 20 of the same year the maximum depth was reached without finding any signs of a possible supply of drinking water.

At a depth of 535 meters (2058 ft.) something unexpected began to appear; at first gas bubbles were observed, then a strong smell of oil. This resulted in drilling being continued to a depth of 540 meters (2072 ft.). On December 13 it was positively proved that oil had been found, and only a short time thereafter the well made a flow, producing ten cu. meters (63 bbl.) of oil.

With this discovery one of the richest and most extensive oil zones in Argentina was found. Further and more intensive drilling operations were undertaken, and for this purpose a new Fauck drilling rig of the same type as the first was used but with a capacity for drilling to a depth of 1000 meters (3280 ft.).

By the end of 1910 there were six producing wells in the Comodoro Rivadavia zone. From that date drilling operations were increased further, as may be seen in Table 1, wherein are given in detail the number of producing oil wells brought in by Yacimientos Petroliferos Fiscales (Y. P. F.), a State division created with the Comodoro Rivadavia oil discoveries. This division has been gradually enlarged until today it embraces in an integral form the entire oil industry of Argentina.

The first drilling at Plaza Huincul (National Territory of Neuquén), which was climaxed with discovery of oil in that zone at a depth of 603-606 meters (1978-1989 ft.) was done with a Fauck drilling rig of the same type as those utilized at Comodoro Rivadavia. Oil was found at Plaza Huincul on October 28, 1918.

Subsequently, drilling was carried on in the provinces of Salta, Jujuy, and Mendoza, with very satisfactory results. These regions still are producing oil. In the National Territory of Río Negro (Nirihuau) and in the province of Santa Fe (San Cristobal) various wildcat wells were drilled, but here only signs of oil were found. (The various zones in the Republic where drilling operations have been carried on may be found in Fig. 1.)

As an illustrative detail it is mentioned here that the well Lunlunta No. 2 (Province of Mendoza), where no oil ever was found, was drilled to a depth of 2476 meters (8124 ft.), it being the deepest well drilled in the Argentine Republic to this date.

On Table 4 it may be seen that General Fiscal Department of Oil Fields listed, at the end of December, 1936, 2563 drilled wells, distributed as follows: 2110 in the Comodoro Rivadavia zone; 300 in the Plaza Huincul zone; 111 in the provinces of Salta and Jujuy; 39 in the province of Mendoza; two in the Gobernación (National Territory) of Río Negro, and one in the province of Santa Fe (San Cristobal).

The first drilling in the Gobernación of Chubut was done with steam, injector-equipped Fauck drilling rigs. In 1914 two Dutch steam drilling rigs were installed, with a capacity for drilling to 800 meters (2625 ft.), and in 1916 and 1917 the first cable-tool drilling rigs from Canada and Penn-

Table 1
Number of exploratory and producing wells

Year	C. Rivadavia		P. Huincul		Salta and Jujuy		Mendoza		Nirihuau		S. Cristobal	
	Exploratory	Producing	Exploratory	Producing	Exploratory	Producing	Exploratory	Producing	Exploratory	Producing	Exploratory	Producing
1907	1											
1908												
1909	3											
1910	2											
1911	...											
1912	1											
1913	3											
1914	1	1										
1915	1	8										
1916	1	14										
1917	3	7										
1918	3	28										
1919	2	16	1									
1920	4	20	2									
1921	...	23	2									
1922	...	32	2									
1923	1	43	6									
1924	3	51	4									
1925	7	119	2	6								
1926	10	131	1	14								
1927	5	122	1	18								
1928	10	131	1	27	1							
1929	9	155	2	26	2							
1930	11	154	...	22	1	3						
1931	24	171	...	30	4	13						
1932	42	157	4	19	8	15	2					
1933	31	124	6	11	2	22	5					
1934	17	122	9	15	4	12	6					
1935	19	145	8	29	7	8	10				1	
1936	23	99	11	19	3	6	16		2			
Total	237	1873	64	236	32	79	39		2		1	

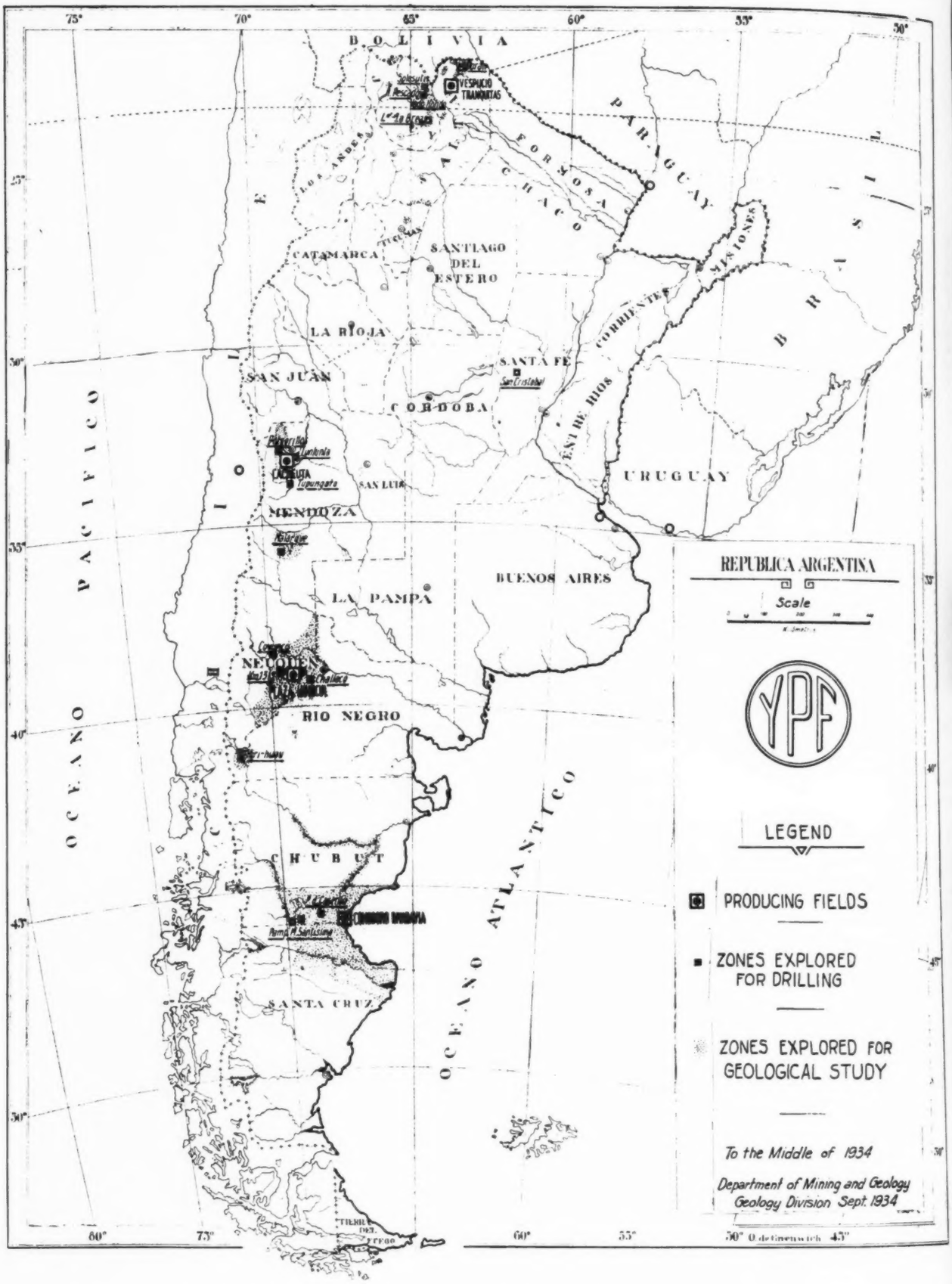


Fig. 1. Various zones in Argentina where drilling operations have been carried on

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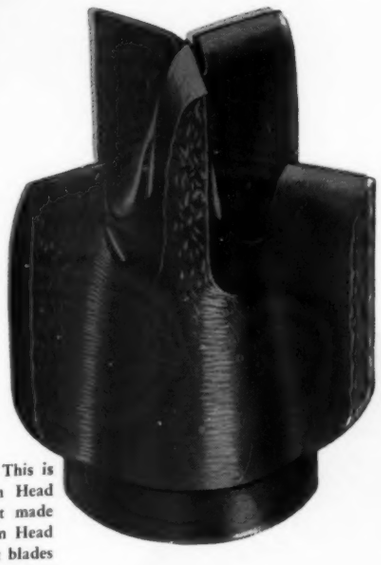

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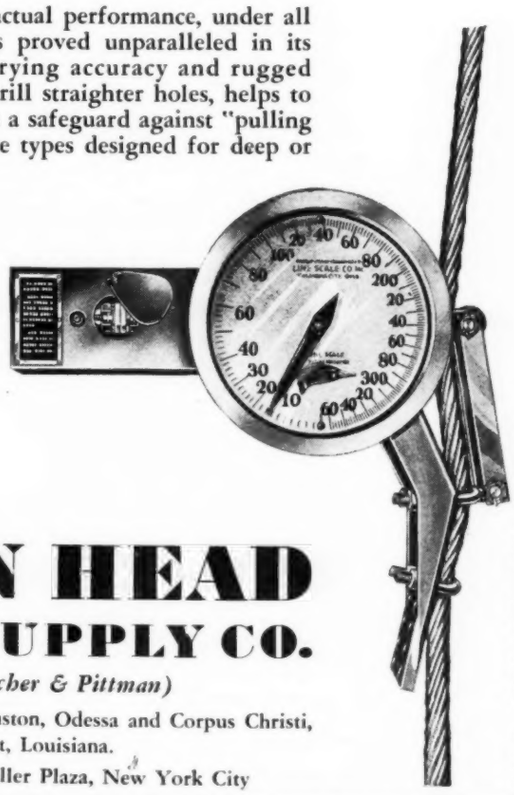

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sylvania were introduced, and after these steam rotary equipment began to be used. In 1925, the General Office of Y. P. F., in its desire to possess the best and most up-to-date equipment, and to economize with efficiency, introduced the electrification of all equipment in the Comodoro Rivadavia field, installing at the same time large electric generators for the production of the necessary power.

In those fields where no central electric plants have been installed, Diesel engines are being employed for drilling and have proved highly efficient.

To the end of 1936, as shown in Table 2, the total footage drilled was 1,830,314 meters (6,005,260 ft.), distributed as follows: 1,486,778 meters (4,878,119 ft.) in the Comodoro Rivadavia field; 233,291 meters (765,-428 ft.) in the Plaza Huincul field; 76,874 meters (252,224 ft.) in the provinces of Salta and Jujuy; 29,736 meters (93,003 ft.) at Mendoza; 2134

Table 2

Number meters drilled from 1907 to December 31, 1936

Year	C. Rivadavia	P. Huincul	Salta and Jujuy	Mendoza	Nirihuau	S. Cristobal	Total
1907	540						540
1908	618						618
1909	643						643
1910	1,074						1,074
1911	480						480
1912	1,771						1,771
1913	1,203						1,203
1914	1,918						1,918
1915	8,233						8,233
1916	8,854	263					9,117
1917	8,372	77					8,449
1918	13,508	285					13,793
1919	13,222	847					14,069
1920	11,384	1,105					12,489
1921	14,054	1,450					15,504
1922	20,454	2,716					23,170
1923	24,302	4,024					28,326
1924	41,958	4,697					46,655
1925	82,159	6,686					89,845
1926	86,954	8,954					95,908
1927	80,692	12,788					93,480
1928	91,677	16,693	827				109,197
1929	115,228	20,344	1,739				137,311
1930	113,298	18,600	2,514				134,412
1931	139,134	21,858	7,698				168,690
1932	149,498	20,202	11,137	1,866			182,703
1933	113,517	17,944	13,610	3,932	835	1,136	150,974
1934	111,049	20,578	13,928	6,191	705	318	152,769
1935	119,759	31,704	14,064	7,282	594	47	173,450
1936	111,225	21,476	11,357	10,465			154,523
Total	1,486,778	233,291	76,874	29,736	2,134	1,501	1,830,314

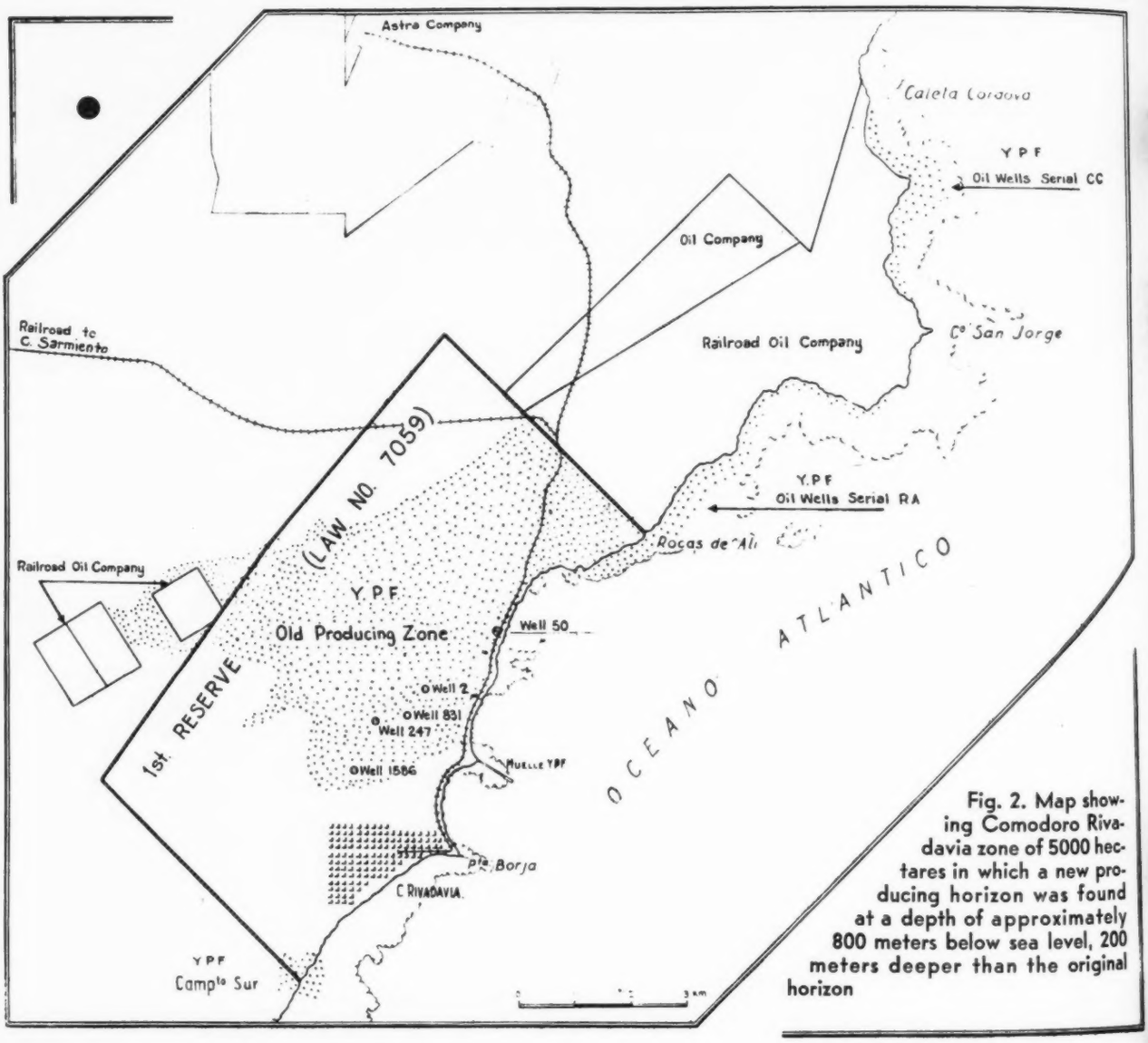

Fig. 2. Map showing Comodoro Rivadavia zone of 5000 hectares in which a new producing horizon was found at a depth of approximately 800 meters below sea level, 200 meters deeper than the original horizon

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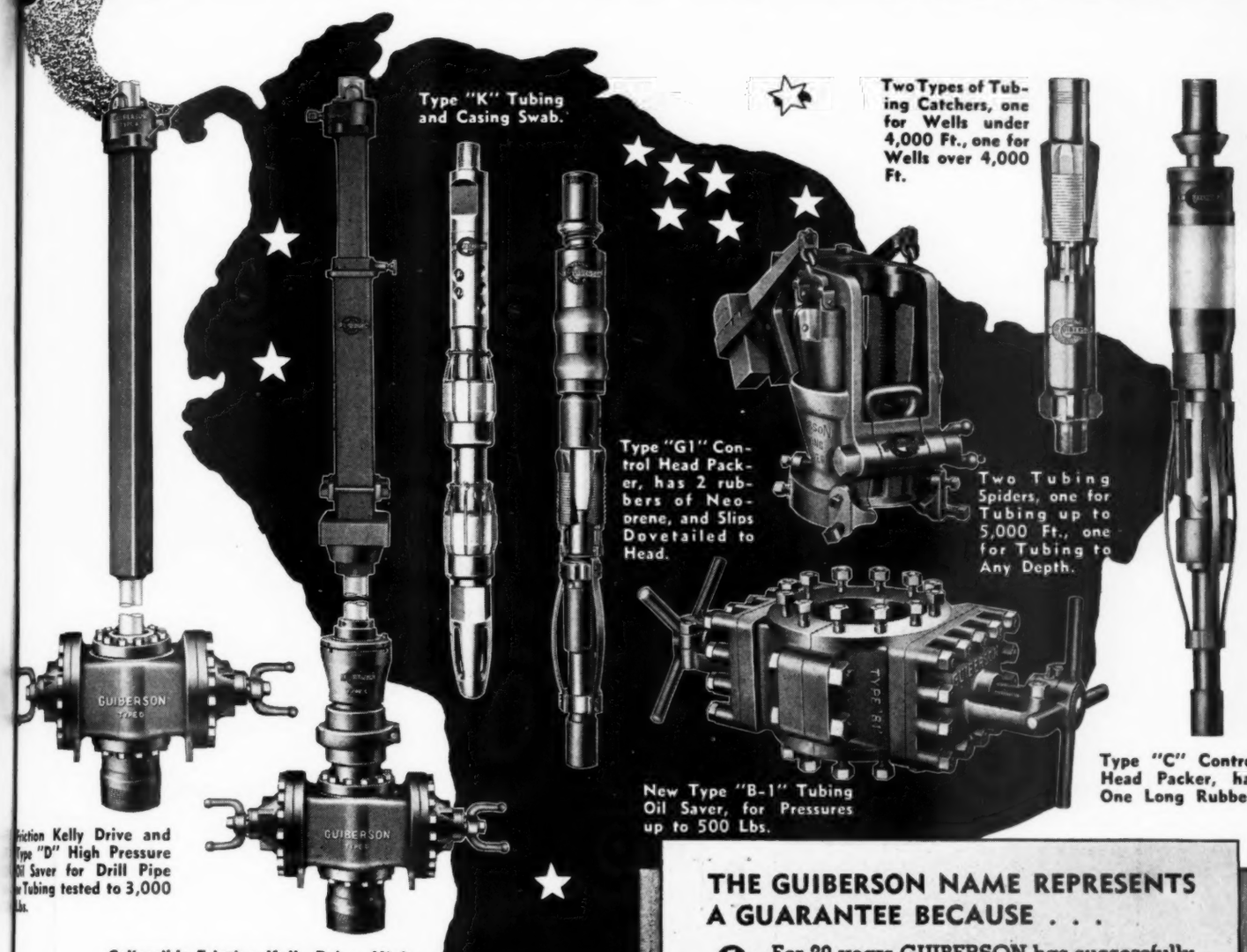

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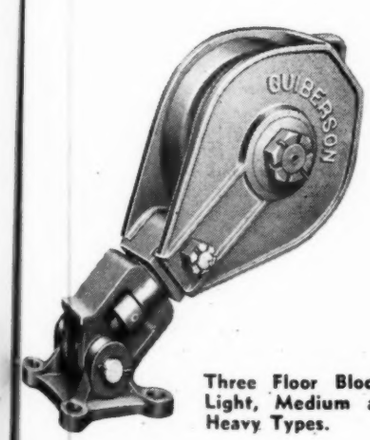

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meters (7002 ft.) in the region of Nirihuau (Gobernación of the Río Negro), and 1501 meters (4925 ft.) in the region of San Cristobal (Province of Santa Fe).

The number of drilling rigs in use at the present time is given in Table 3.

From this table it may be seen that 35, or 43.2 percent of the units are actively engaged in drilling, thereby indicating the great importance that Y. P. F. attaches to drilling operations and to new oil discoveries.

Table 4 shows the results obtained from the 2563 drilling operations performed by Y. P. F. to the end of 1936.

Table 4

Zone	Producing Oil Wells	Non-Producers	Gas Wells	Structural Explorations	Total
C. Rivadavia	1894	131	38	47	2110
Plaza Huincul	250	47	3		300
Salta and Jujuy	94	13		4	111
Mendoza	24	15			39
Nirihuau		2			2
San Cristobal		1			1
Totals	2262	209	41	51	2563

Table 3

	C. Rivadavia	Huincul	Salta and Jujuy	Mendoza	Total
Exploratory drilling	9	7	9	10	35
Drilling in proven fields	19	5	4		28
Structural wells	5				5
Deepening, repairs on wells, etc.	8	1	4		13
Totals	41	13	17	10	81

With regard to the Comodoro Rivadavia zone, it is peculiarly significant that in 1925 there was discovered a new oil-producing horizon immediately beneath that discovered in 1907 in this region, and which latter has produced continuously for 29 years.

The new producing horizon is approximately 800 meters below sea level, 200 meters (656 ft.) deeper than the original horizon, and to the present time it has been ascertained that it embraces a regular, common area, showing certain uniformity with an appreciable production (wells: 1586, 247, 831, 50, etc.). The acquisition of this newly-discovered oil-producing horizon upon the original 5000 hectares zone illustrated in Fig. 2 is of great importance, if it is taken into consideration that the zone is now in production with all installations and improvements already available; drilling, therefore, will not be costly, as the depth is very moderate. The oil produced by these wells is a higher grade than that obtained from oil produced in the same field at higher levels, and fetches a higher price.

Drilling to greater depths than the newly-discovered horizon will be undertaken for the purpose of ascertaining if any other productive horizons are present.

NOTE!

During the past few years, due to sales effort, advertising, and "one man telling another," operators in many fields have learned of a different method of reaming with a tool which is also ideal for stabilizing drilling bits, hole enlargers and core bits; also almost indispensable for many types of directional drilling.

It is apparent that by placing the cutters at an angle so that the top of the cutter leads into the formation, a slicing or shearing action is secured. However, only by making these cutters convex (or barrel-shaped) is it possible to have the cutter, for its full length, in uniform contact with the formation. Thousands of runs have demonstrated that this method secures results which are all that could be desired. The hole is reamed to full gauge, is round, and no tight spots are left to cause difficulty at a later time.

Another extremely important advantage of this design is that the cutting action is performed by the top surface of the disc-like teeth. This produces a slight downward thrust—just enough to hold the bit or core barrel on bottom and obtain maximum cutting on bottom—but not enough to exert any "threading down" action.

Many operators are frank to admit that they consider stabilizing the bit, core barrel, wall scraper or other tool of equal importance with the reaming action, but in any event double duty and double value are present. By having the cutters barrel-shaped and set at the correct angle, they contact from 25 per cent to 35 per cent of the circumference of the hole and maintain an even, concentric contact as long as rotation is continued. The stabilizing, centering action thus secured prevents the bit from "walking" and permits the core barrel or bit to revolve around its true axis and cut the maximum footage of round, vertical, full-gauge hole before becoming worn.

This efficient tool is manufactured by the Security Engineering Co., Inc., with its plant and general offices in Whittier, California. Over-seas operators can secure literature, recommendations and other details from John H. Baird, 420 Lexington Avenue, New York, N. Y., U. S. A. South American operators will find it more convenient to communicate with S. B. Schnitter, No. 4 Mary Street, Port of Spain, Trinidad, B. W. I., who is familiar with conditions in Venezuela, Trinidad and generally throughout South America.

Foreign operators find the Sievers Reamer particularly desirable because of its positive locking device and sturdy construction, which minimize danger of lost parts, and insure safe, continuous operation. Simplicity of design makes it an easy matter to take the tool apart when making replacements.

Please refer to page 66 of this publication where both single-three-point and double-three-point Sievers Reamers are illustrated.

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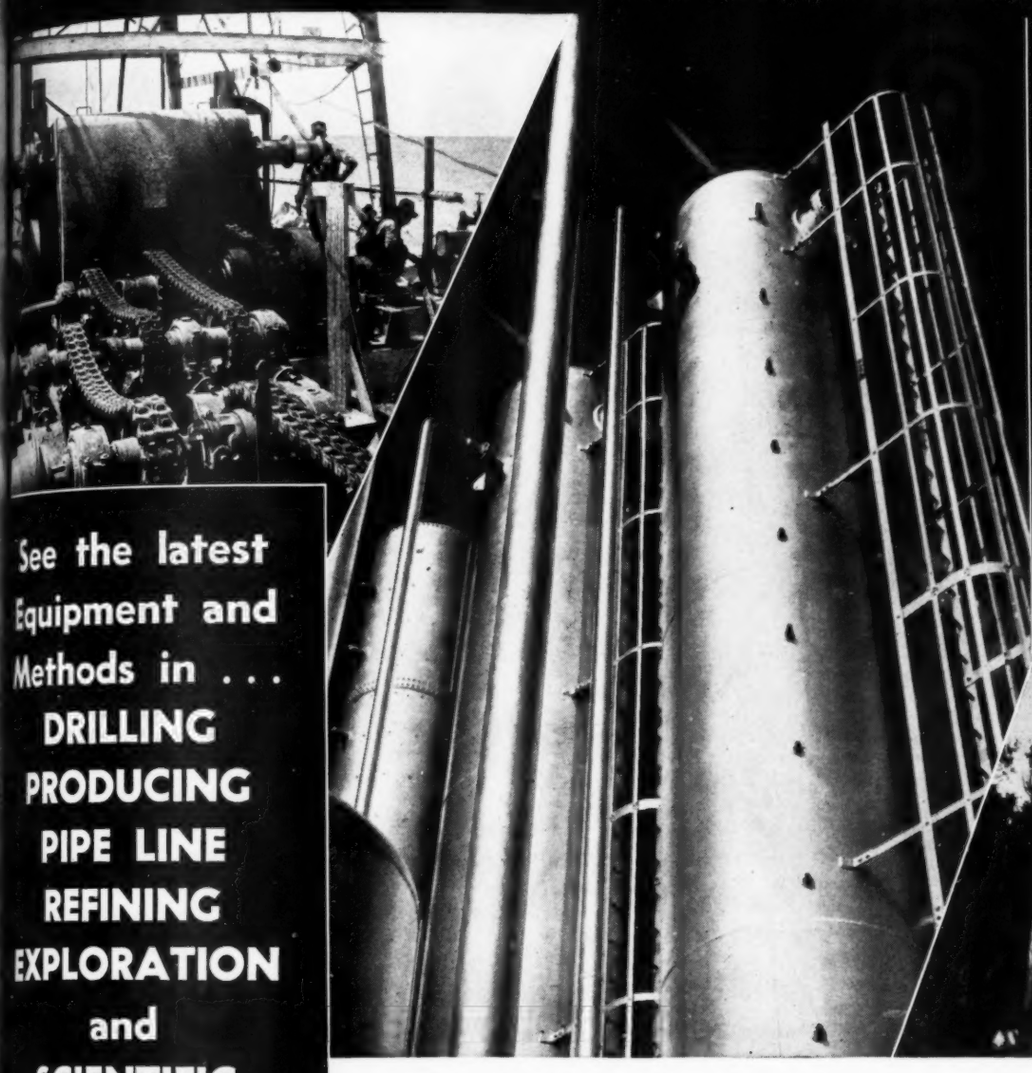

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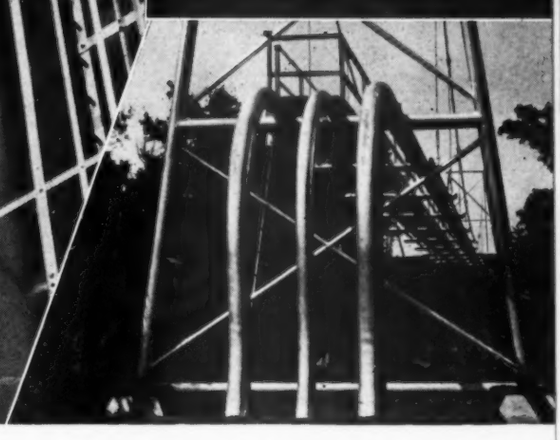

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Producing wells at Restinga de Ali, Comodoro Rivadavia zone

Production and Production Practice in Argentina

OIL production in the Argentine Republic is under the general supervision of Yacimiento Petroliferos Fiscales (Y.P.F.), or the Argentine Government Oil Fields. Oil first was discovered December 13, 1907, in the Comodoro Rivadavia (National Territory of Chubut) area, latitude 46 degrees, in the southern part of the Republic. Three other oil fields since have been developed. They are: Plaza Huincul, discovered in 1918, Salta, in 1928, and more recently Mendoza, discovered in 1932. From Table 1 it may be noted that the principal production is from the Comodoro Rivadavia field, the other three producing only a minor portion of the total, with the result that of the total oil output from the Republic between 1907 and 1936 the Comodoro Rivadavia Field produced 92.8 percent, and the three other areas combined only 7.2 percent.

The first oil discovered in the Argentine Republic was in the Comodoro Rivadavia area, December 13, 1907 — three other fields since have been developed

From 1907, when oil was discovered, to the present time there have been two outstanding periods of activity. One from 1907 to 1926, when activity in the oil industry gained momentum as crude became the principal fuel, and from a production of 16 cu. meters (101 bbl.) in 1907, the output reached a total of 743,739 cu. meters (4,677,-895 bbl.) in 1927, with a total production for the 20-year period of 4,-044,738 cu. meters (25,440,189 bbl.).

From 1927 to 1931 production remained stationary, and during this period the total was 4,257,455 cu. meters (26,778,115 bbl.), this figure representing an average yearly output of 851,491 cu. meters (5,355,623 bbl.). On the other hand, from 1932 to the present, with improvements introduced, production increased gradually, totaling 4,743,641 cu. meters (29,836,079 bbl.), a yearly average of 948,728 cu. meters (5,967,215 bbl.). The increase was even more noticeable in 1936, reaching 1,140,188 cu. meters (7,171,440 bbl.). This rate of increase also has been maintained so far this year; between January and March the daily average production was 3,400 cu. meters (21,385 bbl.), or a net 10 percent increase over the 1936, and 50 percent over the 1927 average.

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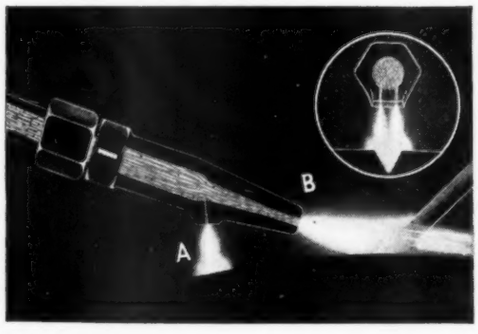
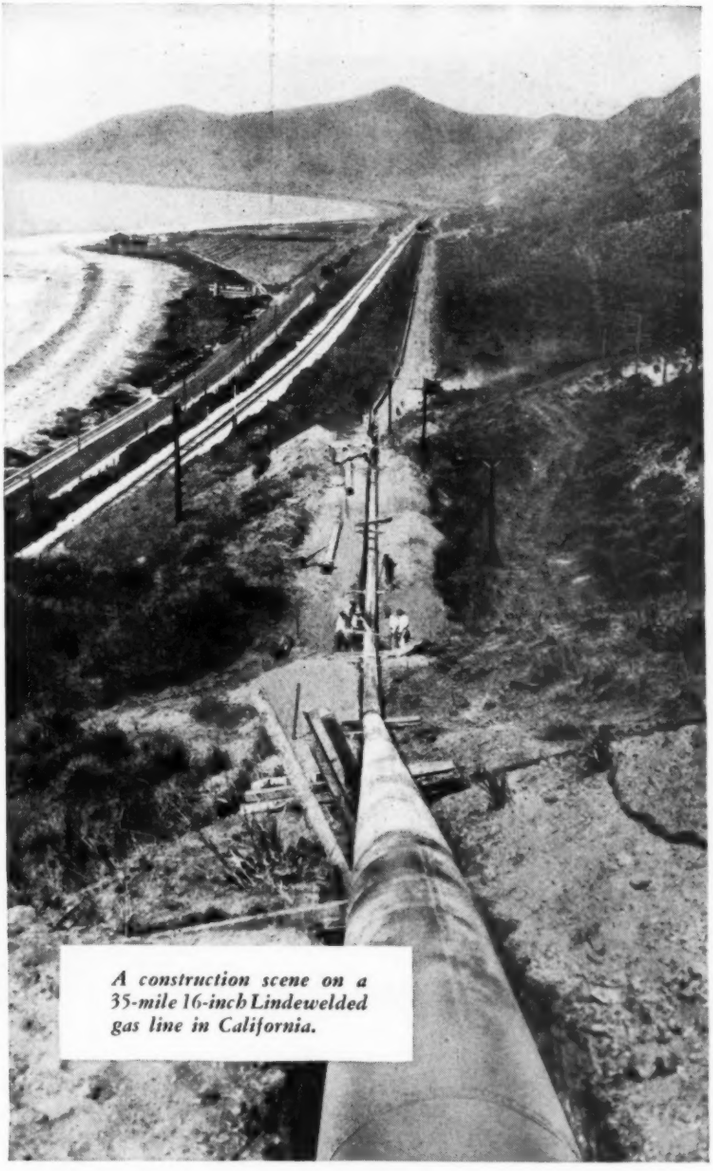


This schematic cross section shows the Multi-Flame Lindewelding Head in action. The small flames, A, preheat the pipe while the main flame, B, melts the welding rod and postheats the weld. In the circle is a cross-sectional view through the preheating flames, A.



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PRODUCING FORMATIONS

Comodoro Rivadavia. It has been stated previously that these oil formations are the most important, both in extent and in production. They derive their name from a neighboring town. The original discovery of oil was made while searching for water. Realizing the importance of the discovery, on December 24, 1910, the National Government founded in Comodoro Rivadavia the National Oil Administration, which took charge of operations in the territory. By decree of June 3, 1922, the National Oil Administration was changed into Department of Government Oil Fields, or Y.P.F.

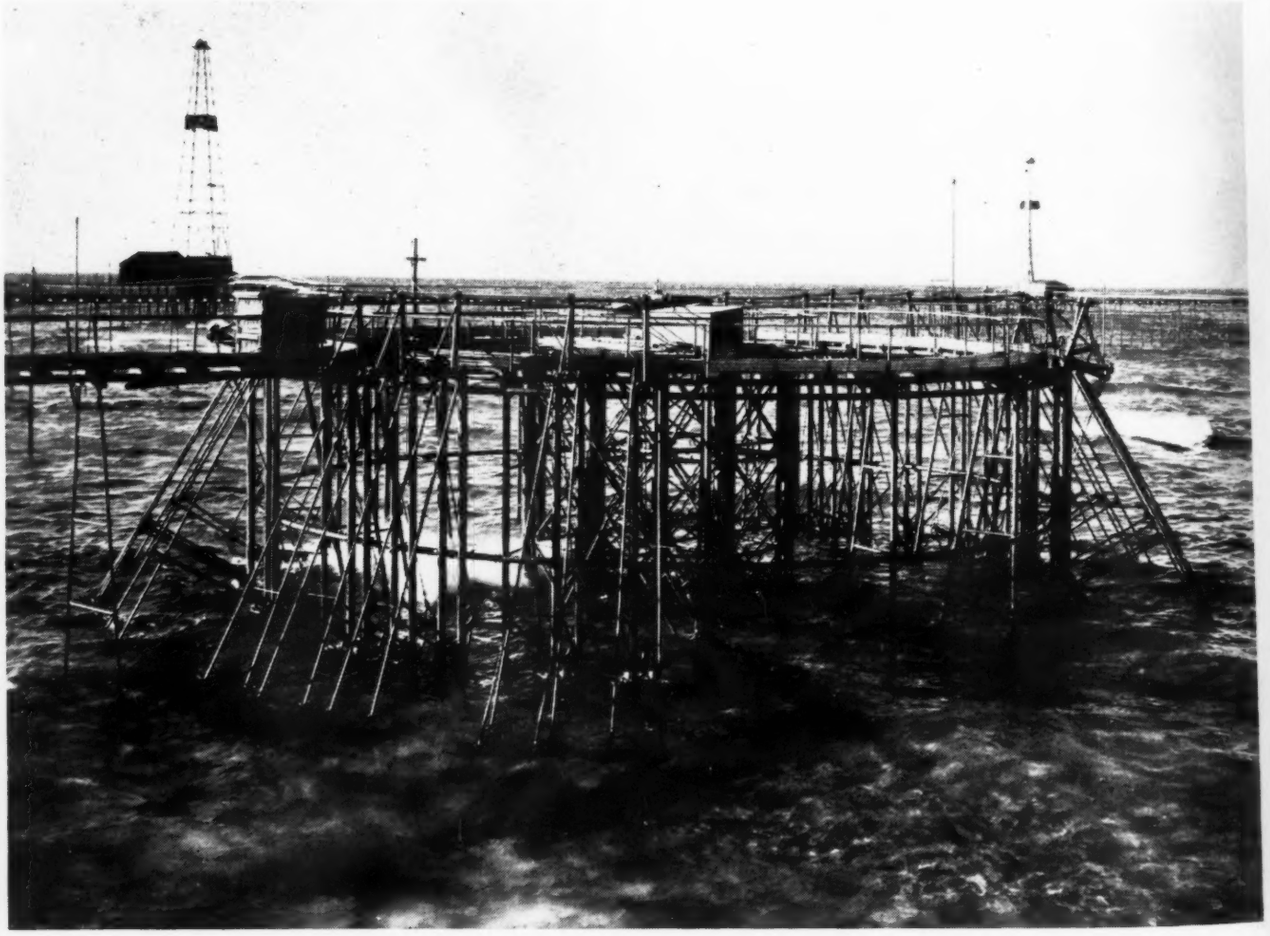
Until 1927 operations were limited to the reserve zone, formed by virtue of a decree of August 29, 1910, and having a superficial area of 5000 meters, which by 1935, was literally covered with oil-producing wells. These wells had been drilled to exploit the oil sands found at depths of 500 and 600 meters (1641 ft. and 1969 ft.) below sea level, the upper sands including the Glauconítico, Lignitífero, and Horizonte Madre, and the deeper sands the Horizonte Continental. In 1935 there was found in this zone a new horizon

TABLE I
Production in Cubic Meters[1]

Year	C. Rivadavia	P. Huincul	Salta	Mendoza	Total
1907	16				16
1908	1,821				1,821
1909	2,989				2,989
1910	3,293				3,293
1911	2,082				2,082
1912	7,462				7,462
1913	20,733				20,733
1914	43,795				43,795
1915	81,580				81,580
1916	129,780				129,780
1917	181,704				181,704
1918	197,573	13			197,586
1919	188,093	20			188,113
1920	226,544	611			227,155
1921	277,807	919			278,726
1922	343,910	4,978			348,888
1923	400,048	7,138			407,186
1924	544,367	9,554			553,921
1925	609,272	14,764			624,036
1926	720,243	23,496			743,739
1927	792,364	30,511			822,875
1928	811,931	47,532	1,141		860,604
1929	807,213	61,853	3,105		872,171
1930	721,592	89,927	16,494		828,013
1931	748,337	101,895	23,360		873,592
1932	788,899	93,525	19,579	252	902,255
1933	816,281	66,337	37,809	1,361	921,788
1934	760,019	52,247	20,747	2,551	835,564
1935	857,026	61,516	19,509	5,795	943,846
1936	1,018,299	79,010	33,298	9,581	1,140,188
Totals	12,105,073	745,846	175,042	19,540	13,045,501

[1]One cubic meter = 6.2897 bbl.

A group of wells off-shore pumped from a central power, Caleta de Cordoba, Comodoro Rivadavia zone



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some 300 meters (984 ft.) below the Horizonte Continental; this horizon was given the name of Horizonte Profundo. It has been determined that this latter embraces an area comparable to that of the previous two upper horizons. Its production is high and the oil is of an excellent quality. Thus, this recent discovery bears almost the same significance as the first discovery 28 years before.

In 1928, and after exploration advanced toward the west and new zones were discovered, the exploitation of Cañadón Perdido was begun; and in 1932 the exploitation of Escalante began. These two zones lie 25 and 32 kilometers, respectively, from the Antigua Zona de Reserva (Old Reserve Zone). Finally, in 1933 exploitation operations were begun at las Restingas, zones adjacent to the seacoast, where at the present time 197 wells are producing within an area of 13 kilometers.

TABLE 2

Zones	No. of producing wells	1936 production in cu. meters	Total cumulative production in cu. meters	Area per well in hectares	Daily av. production per well (Dec., 1936) in cu. meters
Central Zone	1,134	442,392	9,815,307	2.51	1.090
Cañadón Perdido	130	195,765	973,027	2.15	6.740
Escalante	66	107,862	759,551	5.33	4.030
Restingas	141	269,995	546,623	1.94	5.109
Exploraciones	8	2,285	10,565	.....	.....
Totals and averages	1,479	1,018,299	12,105,073	2.73	2.106

At Cañádón Perdido the same series of sands as those in the Central Zone (Old Reserve Zone) are being developed. At Escalante the Continental is being developed, the Glauconítico producing gas exclusively. Production from las Restingas results from a merger of the Glauconítico and the Lignitífero.

Despite the fact that these horizons are below sea level, as has been stated, the depth of the wells increases with the distance from the west seacoast. This is due to gradual elevation of the subsoil and of the soil that forms a series of small table lands rising higher and higher and linked together by chains of hills and mountains, at the foot of which numerous wells also have been drilled. Thus, while the depth of the las Restingas wells averages 600 meters (1969 ft.), it increases to 800 meters (2625 ft.) a few kilometers from the coast, the depths at Cañadón Perdido being of from 800 to 1000 meters (2625 ft. to 3281 ft.), and in Escalante from 1000 to 1200 meters (3281 ft. to 3937 ft.). It may be added that drilling operations conducted more toward the central part of the country found oil-bearing strata at depths of more than 1500 meters (4922 ft.).

Table 2 shows the most important details of oil production toward the end of 1936, with regard both to quality and to zones.

Plaza Huincul Fields. These are situated in the western part of the Republic, at 39 deg. latitude, in the National Territory of Neuquén. They have been producing since 1918. Production here also was discovered by the Department of Mines, Geology, and Hydrology, having come under the direction of the Department of Y.P.F. in 1922.

Development here is in three zones known as Campamentos (Camps) No. 1, No. 2, and No. 3, in accordance with the order in which they were discovered in the years 1918, 1925, and 1927, respectively, with a combined

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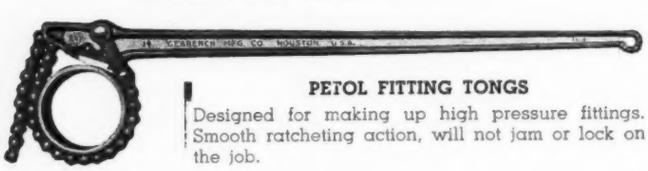

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TABLE 3

Zones	No. of producing wells	1936 production in cu. meters	Total cumulative production in cu. meters	Area per well in hectares	Daily av. production per well (Dec., 1936) in cu. meters
Campamento No. 1	51	12,267	224,183	1.10	0.602
Campamento No. 2	66	34,716	170,230	1.48	1.318
Campamento No. 3	48	27,833	345,870	1.38	1.790
Exploraciones	4	4,194	5,563	.....	.....
Totals and averages	169	79,010	745,846	1.32	1.237

area at the end of 1936 of 220 hectares distributed as follows: 36 for Campamento No. 1, 98 for No. 2, and 66 for No. 3. The figures in Table 3 show the production status of this zone.

The wells in these fields exploit the sandy formations, at depths varying from 600 to 800 meters (1969 to 2625 ft.), the shallower depth corresponding to Campamento No. 1 and the deeper to Campamento No. 3.

Salta Fields. These fields are situated in the northern part of the Republic, within the province of the same name, and include the zones Campamento Vespucio (Republic Argentine Mine) and Tranquitas, which began producing in 1928 and 1931, respectively.

The Campamento Vespucio zone embraces an area of 29 hectares, and its production has reached its peak. The oil here is from the calcareous formation of the "Gondwana" and is found at a depth of from 500 to 600 meters (1641 to 1969 ft.). The producing horizon at Tranquitas, which last year definitely was learned to be a narrow incline running almost on a due north and south line for a distance of six kilometers, is the same oil formation as that found at Vespucio, and the wells become deeper toward the south end. Thus, in wells toward the north, oil is found at a depth of 300 meters (984 ft.) while toward the south the oil-producing sands are 1000 meters (3281 ft.) and more in depth.

There also are signs that the incline is richer in oil as it moves southward. This fact has been ascertained by the greater production of the wells. Wells in this area are more widely spaced as a result. On the other hand, in the northern part of the field wells are spaced 80 or 100 meters (262 or 328 ft.) from each other, and after having produced beyond the production limit for a certain period, declined very rapidly until they reached an average well production. Characteristic examples of this are wells T. 10, T. 12, and T. 13, which in 1933 produced a total of 13,070 cu. meters (82,106 bbl.), or approximately 35 percent of the total production for this zone.

Table 4 gives a resumé of the production in these beds at the end of 1936.

Mendoza Fields. These fields are situated in the province of Mendoza, in the western part of the Argentine Republic, at 33 deg. latitude.

Exploitation here began in 1932 in the Cacheuta area, upon a property of the Mendocina Oil Company. One of the company's wells, the Victor, was reworked and began producing again, thus encouraging the drilling and reworking of other wells.

In 1934 oil was found in the Tupungato area. Production remained at an even level, however, and was only sufficient to provide fuel for the area, continuing at that level until last year, when steps were taken to intensify op-

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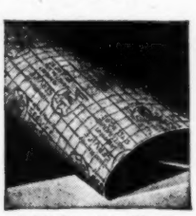

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TABLE 4

Zones	No. of producing wells	1936 production in cu. meters	Total cumulative production in cu. meters	Area per well in hectares	Daily av. production per well (Dec., 1936) in cu. meters
Camp. Vespucio	18	2,846	76,499	1.56	0.484
Tranquitas	55	29,244	96,057	1.36	1.598
Exploraciones	1	1,208	2,486		
Totals and averages	74	33,298	175,042	1.46	1.041

TABLE 5

Zones	No. of producing wells	1936 production in cu. meters	Total cumulative production in cu. meters	Daily av. production per well (Dec., 1936) in cu. meters
Cacheuta	15	6,389	13,550	2.791
Tupungato	10	3,186	5,984	1.026
Exploraciones	1	6	6	
Totals and averages	26	9,581	19,540	1.904

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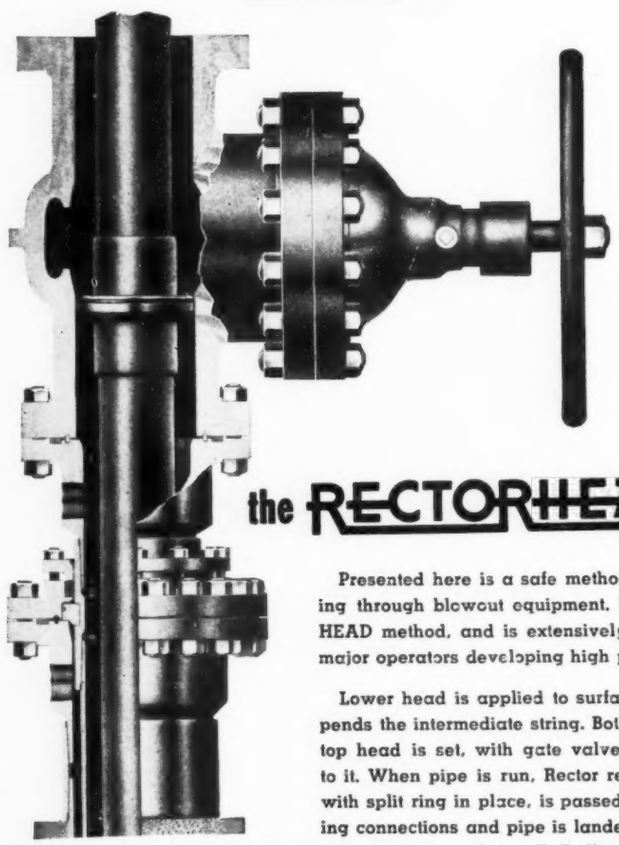


the RECTORHEAD way

Presented here is a safe method of landing casing through blowout equipment. It's the RECTORHEAD method, and is extensively used today by major operators developing high pressure fields.

Lower head is applied to surface pipe and suspends the intermediate string. Bottom flange of the top head is set, with gate valve flanged directly to it. When pipe is run, Rector recessed coupling, with split ring in place, is passed through all drilling connections and pipe is landed on a steel seat without opening the well. Drilling connections are then removed and Rector top flange applied.

Note that both iron ring packing and hydraulic packing are furnished.

RECTORHEAD Patents: 1,834,868; 1,869,739; 2,083,089; 2,083,090; 2,083,091. Other Patents Pending.

RECTOR

erations. At that time, too, construction of a refinery, which now is in operation, began.

Production in the area during 1936 is given in Table 5.

In the Cacheuta zone the depth of the wells varies considerably due to the marked slant of the formation. Where it crops out wells have been drilled to a depth of 60 meters (197 ft.). Drilling depth, however, varies widely and other wells have been drilled to a depth of 1000 meters (3281 ft.). In other words, conditions in this area are very similar to those in the Tranquitas (Salta fields) area. Here the product extracted is known as oil product "Rético." At Tupungato the depth of wells is approximately 550 meters (1640 ft.), and oil production has not been clearly defined, as it flows naturally accompanied by considerable water.

PRODUCTION METHODS

In most instances the wells are pumped, but some flow naturally or by artificial methods. Of the 1747 producing wells at the end of 1936, 1597, or more than 91 percent, were produced by pumping.

A variety of conditions and methods exist due to the varied production of the wells, some of which produce only a few hundred liters (159 liters = 1 bbl.) daily, while others produce much more. The various grades of the oil produced, the different oil formations, and the irregularity in the depths of the wells, the topography, and the variety of climate, also are factors that prevent a uniformity of operation.

Here are outlined the chief characteristics of production operations for each of the above-named fields:

Comodoro Rivadavia Field. Due to the great number of wells that have only a small production, wells are pumped from central powers, each power pumping an average of 18 wells.

Central powers of this kind have been installed recently in Las Restingas, erected upon iron platforms supported by columns of a height sufficient to maintain the power above the high tides of the sea. The equipment used is of the gear speed-reducer type, hermetically closed in an oil bath, which

TABLE 6

General Status of Wells

	Comodoro Rivadavia	P. Huincul	Salta and Jujuy	Mendoza	Totals
On production	1,479	169	74	25	1,747
Gas wells	17	5	....	....	22
Gas injection wells	28	17	....	....	45
Under observation	42	1	2	....	45
Production temporarily suspended	227	40	15	....	282
Abandoned and to be abandoned	239	68	19	15	341
Totals	2,063	300	110	40	2,513

equipment has proved both technically efficient and economical.

Wells producing larger volumes, and those making considerable water, are pumped with individual units. Wells in isolated districts, and in foothill regions, where they are not readily accessible, also are pumped in this manner.

In general, the crude oil produced in the area is very viscous, and necessitates lengthening the pumping stroke and reducing the pumping speed. This has resulted in greater efficiency and increased production, as well as prolonging the life of sucker rods and shackle lines.

When the fields were new, wells in the Escalante and la Restinga de Caleta de Córdoba produced by natural flow, and when reservoir pressure declined and natural flow no longer was possible, gas-lift was employed. Pneumatic pumping has been tried in Escalante, but this method has not been generally adopted because the results have not yet justified doing so.

Deep wells drilled recently have been produced by natural flow. At the present time hydraulic pumps are being installed on some of the wells. It is thought this equipment may be successful as the crude is viscous and much of it has a high paraffin or asphalt content.

Attempts made in the Central zone to restore pressure in the producing formations by injecting gas under pressure have not been satisfactory for several reasons: the long time these formations have been producing, water encroachment and particularly the lenticular nature of the formations and the presence of slides, all which together have caused a dissipation of gas and gas energy. On the other hand, it is believed that tests on the Cañadón Perdido, Escalante, and the Restinga de Caleta de Córdoba, where the area is more limited, will meet with better success.

The gas-lift installations are powered by electric motors receiving their current from a central generating plant, which was installed in 1925. A lack of water and gas caused the abandonment of steam plants in 1925.

Plaza Huincul Fields. In these fields a similar procedure is employed for producing the wells as that just discussed. Power is provided by steam engines or by internal combustion engines.

Pneumatic pumping has given satisfactory results in these fields and at the present time this system is being installed on wells in the Campamento No. 1 area. Employing the compressors that are necessary to the pneumatic pumping, gas-lift has been tried in the area, but with no results of consequence due to the lack of uniformity of oil formations and due also to the many slides.

On the other hand, in Campamento No. 3, the formation presents an enlarged monoclinical aspect, offering favorable conditions for the success of gas-lift.

Salta Fields. The wells in the Campamento Vespucio zone are produced by means of central powers, with the exception of a few isolated wells, these being operated by individual pumping units.

In the Tranquitas zones, where the wells for some distance have been drilled in a double row on irregular land covered with tropical vegetation, it would have become necessary to exploit these wells with separate units, with a small profit, as their production is very small; however, by applying the pneumatic pumping method, except in cases of wells flowing naturally, this problem has been solved.

Mendoza Fields. The wells in the Tupungato zone flow naturally, and their production is small, the oil being accompanied by considerable water.

At Cacheuta some of the wells are pumped both by central powers and individual units, depending upon local conditions. Central powers are driven by steam or internal combustion engines.

Hydraulic pumps are being considered for this area, as the crude is highly viscous and this condition is accentuated by the low temperature prevailing the year around.

Table 6 gives a complete resumé of production from the wells completed to the end of 1936.

Production by Private Oil Companies

Since 1916, a few years after the discovery of oil in Agentina, several private companies have been operating in other fields within the areas mentioned.

At Comodoro Rivadavia. In 1916 the Compañía Ferrocarrilera de Petróleo (Railroad Oil Company) and Astra, S. A. (Astra Company), began operations in this area. In 1920 El Sindicato, now property of Astra, S. A., began operations. Other companies followed in the order named: Compañía Industrial y Comercial de Petróleo (Industrial and Commercial Oil Company), 1921; Solano, Oriente, and Diadema Argentina, S. A., 1925. This latter company in 1933 acquired the properties of the companies Antorcha Argentina, Brillante, Perla, and Rubi, which were founded in 1926, with the exception of Rubi, established in 1927. In 1933 Astra, S. A. bought Oriente. In 1935 Solano and Compañía Industrial y Comercial de Petróleo became the property of the Compañía Ferrocarrilera de Petróleo.

TABLE 7

Company	Production in 1936 in cu. meters	Total production in cu. meters
Ferrocarrilera de Petróleo[1]	240,602	3,557,061
Astra S. A.[2]	170,376	2,275,133
Diadema Argentina S. A.[3]	570,644	2,817,419
Standard Oil Co.[4]	332,419	2,532,375
Río Atuel Ltda.	2,865	33,514
Total	1,316,906	11,215,502

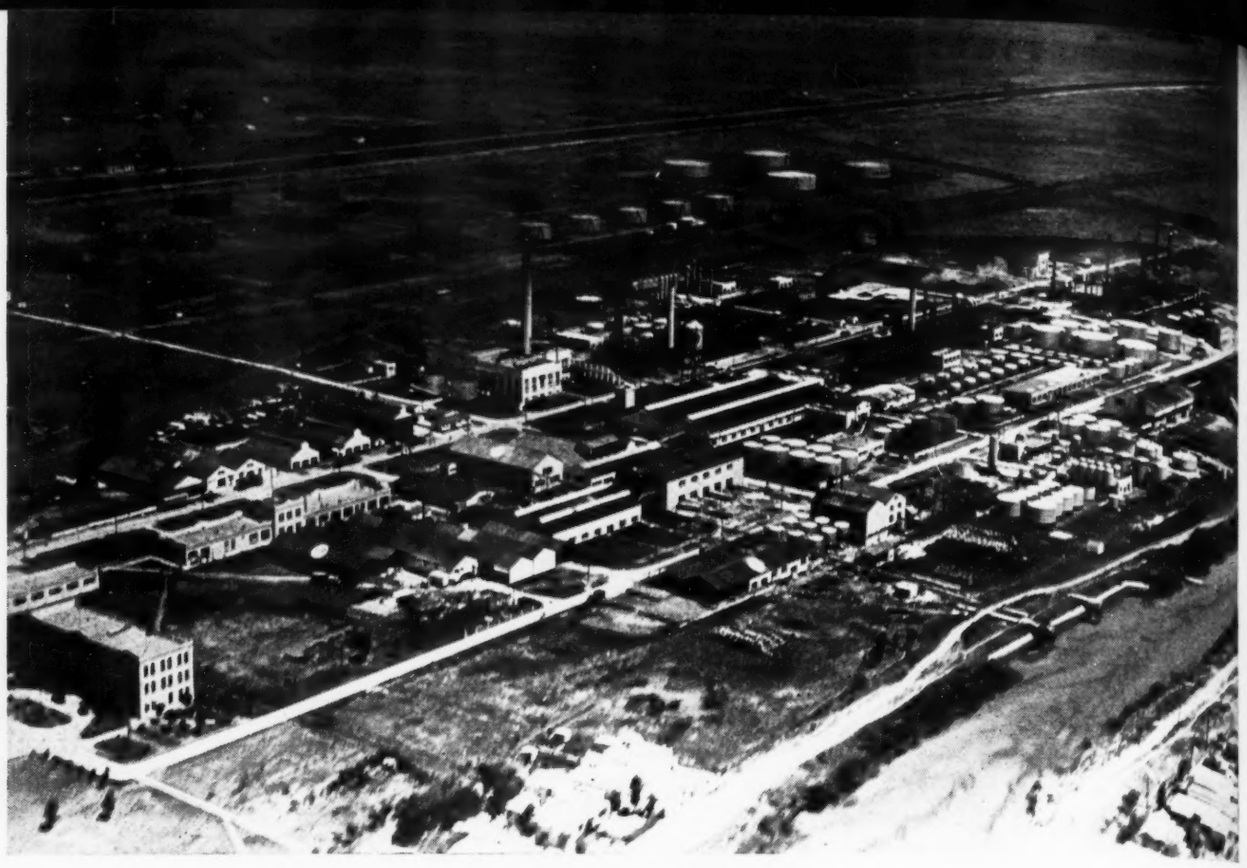
[1]Including Solano, Compañía Industrial, and Comercial de Pertróleo.
[2]Including Oriente and El Sindicato.
[3]Including Antorcha Argentina, Brilliante, Perla, and Rubi.
[4]Including La República Ltda.

At Plaza Huincul. In 1923 the República Ltda., in 1926 the Standard Oil Company, and in 1930 Astra, S. A. were established. At the present time Standard Oil Company has acquired the La República Ltda.

At Salta. Standard Oil Company began operations in 1926, and at **Mendoza** the Río Atuel Ltda. has been operating since 1926.

In Table 7 are listed the private companies now operating.

Production by private companies represents 46.4 percent of the total oil production in the country.



Aerial view of refinery at La Plata

Refinery Operations in Argentina

Though a refinery was constructed in the region of Campana as early as 1905, oil refining did not attain great importance until 1925—output of refined products showed a marked increase in 1936

IT was in 1905 that the oil industry of the Argentine Republic had its beginning. A group of business men organized the Compañía Nacional de Petróleo (National Oil Company) and erected a refinery in the region of Campana. In 1911, when the West India Oil Company took charge of the sale of oil products, additional refining equipment was installed. The West India Company subsequently was absorbed by the Standard Oil Company.

By the end of 1913 construction of the first fiscal refinery in the Comodoro Rivadavia zone was begun, and on May 6, 1914, it was placed in operation. The installation consisted of a battery of cylindrical stills with a capacity of 350 cu. meters (2201 bbl.) daily. Only naphtha and kerosene were extracted as refined products, leaving as a residue (87 percent), fuel oil.

The oil refining industry did not acquire much importance until 1925. At this time the total cumulative oil production of the Argentine Republic was 4,187,863 cu. meters (26,340,402 bbl.), of which only 1,100,000 cu. meters (6,918,670 bbl.) were refined, the remaining 75 percent being consumed in its natural state for fuel purposes, as a substitute for coal or charcoal and for burning in Diesel engines.

A new refinery was installed December 23, 1925, by the Y. P. F. in the La Plata region. The installation of this modern equipment marks the real beginning of the refining industry in Argentina.

Table 1 gives statistical data on oil refining in the country, showing a marked increase in the volume of oil refined during 1936.

The La Plata plant was the first to be installed in Argentina with modern refining equipment. This equipment consists of a primary refining unit, continuous system, of tube still and battery, with towers for refining vapors and for the residue. For cracking, two Cross units with all necessary auxiliary equipment were erected. These units are equipped with bubble and Gray towers for the production of refined naphtha.

Only naphtha, kerosene, and fuel oil were refined in this plant in 1926. Agricol (kerosene for tractors) was added in 1927, and in 1928 Diesel fuel oil was manufactured. With the installation of a new fuel oil tube cracking still and a third Cross unit, the production of naphtha was increased and tractor oil was processed. The output again was increased in 1931 with the installation of a second primary plant, and improvements made on the topping plant initially installed by perfecting its separation process and increasing its capacity.

New equipment, valued at 10,000,000 pesos, was added to the refinery during 1932 and 1933, making the capital invested in the plant 32,000,000 pesos. A liquid gas plant and a number of units for the processing of lubricating oils were installed. The latter units included an Edeleanu-process refining plant; a deparaffination filter-press, and a Sharples centrifugal deparaffination plant. During this period four more Cross cracking units were installed. Being of more flexible type than the ones installed earlier, the new units are capable of processing anything from kerosene to fuel oil.

The Compañía Ferrocarrilera de Petróleo (Railroad Oil Company), following the example set by the Y. P. F., in 1926 installed in Comodoro Rivadavia a modern refinery, equipped with topping units, Cross cracking,

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TABLE I

Oil Industralization in the Argentine Republic

CRUDE PRODUCTS

Year	Produced in Country Cubic Meters	Imported Tons	Fiscal From Rivadavia Tons Consumed	Crude National and Imported Tons	Naphtha Cubic Meters	Kerosene Cubic Meters	Gas oil and Diesel oil Refined Tons	Fuel oil Tons	Lubricating oil Tons
1907	16	....	....	....	....	....	....	....	....
1908	1,821	....	....	....	....	....	....	....	....
1909	2,989	....	....	....	....	....	....	....	....
1910	3,293	....	....	....	....	....	....	....	....
1911	2,082	....	1,757	....	....	....	....	....	....
1912	7,462	(a)	300	....	....	....	....	....	....
1913	20,733	....	....	....	....	....	....	....	....
1914	43,795	....	20,641	(b) 1,133	(b) 22	(b) 55	....	(b) 1,035	....
1915	81,580	....	66,848	2,289	44	30	....	2,135	....
1916	137,551	71,072	87,498	72,849	70	60	....	1,600	....
1917	192,371	20,240	140,714	24,807	263	400	....	3,850	....
1918	214,867	9,176	162,168	17,096	449	810	....	6,500	....
1919	211,300	36,708	162,098	46,597	469	919	....	8,286	....
1920	262,495	31,426	153,266	46,470	607	1,047	12	13,310	....
1921	326,905	24,353	185,751	44,323	1,067	1,390	....	17,000	....
1922	455,498	19,528	253,328	228,943	23,511	16,407	14,207	184,076	....
1923	530,209	45,257	364,853	307,011	36,809	23,312	20,467	225,919	....
1924	740,697	70,917	285,050	360,753	49,782	30,231	25,365	272,155	....
1925	952,199	76,311	493,326	359,264	51,789	29,328	34,798	245,620	....
1926	1,248,118	148,124	94,949	1,019,903	102,682	62,823	30,739	821,082	....
1927	1,372,020	193,595	....	1,272,054	191,691	90,034	45,550	980,837	....
1928	1,442,072	317,466	....	1,439,348	296,329	87,761	62,541	1,055,275	....
1929	1,493,067	487,983	....	1,856,332	504,238	90,617	70,289	1,106,340	....
1930	1,431,107	547,893	....	1,862,486	600,936	122,824	76,266	1,040,234	....
1931	1,861,413	358,741	....	2,104,155	687,527	117,844	183,197	1,124,108	....
1932	2,088,831	224,341	....	2,153,897	782,455	146,436	213,770	1,050,310	21,870
1933	2,176,559	155,578	....	2,051,118	747,090	138,695	242,202	1,025,015	27,263
1934	2,229,714	169,542	....	2,183,666	821,034	149,556	262,470	1,019,362	30,061
1935	2,272,977	407,610	....	2,444,677	960,156	175,336	245,000	1,066,506	45,682
TOTAL	21,803,741	3,415,861	2,472,547	19,899,171	5,859,020	1,285,915	1,526,873	11,270,555	124,876

(a) No definite figures of imported crude prior to 1916.
(b) Fiscal crude processed and products obtained—imported not included. No data from private refineries available for this period.

and Gray towers. This refinery processes only naphtha, utilizing the remaining fuel oil in railway locomotives, the company owning many railroads in the country.

From 1926 to 1931 the private companies intensified oil production and the volume of naphtha processed.

The Compañía Nacional de Petróleo (National Oil Company), a subsidiary of the Standard Oil Company of New Jersey, enlarged and modernized its refinery at Campana, equipping it properly for the processing of oil produced at Salta by the Standard Oil Company. At the same time a new refinery was constructed at Puerto Galván to handle oil produced by the company in its Plaza Huincul fields.

In August, 1934, the refinery at Campana was destroyed by fire, and subsequently was rebuilt, being equipped with the most modern equipment. At the present time it is equipped with a topping and re-distilling unit, cracking equipment, a unit for refin-

Topping plant and tube stills in refinery at La Plata

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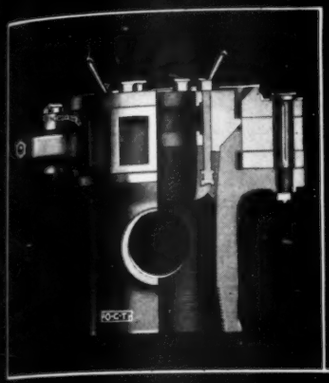

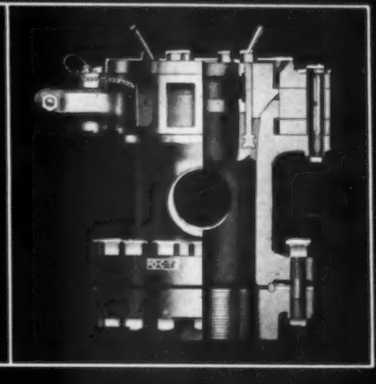

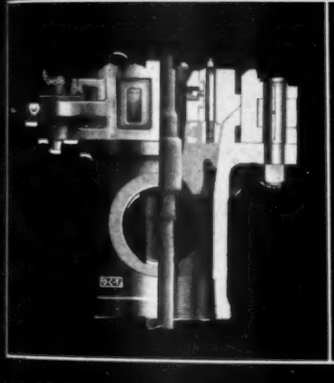

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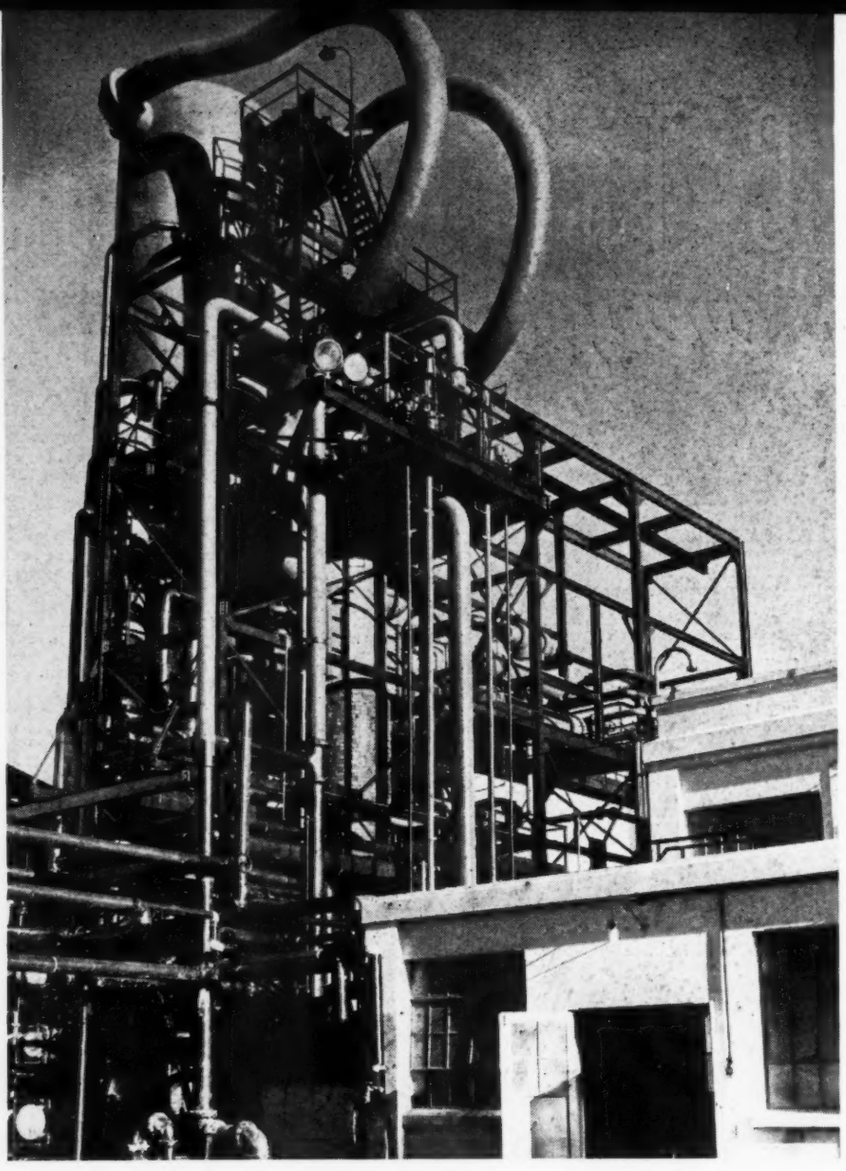


Lube oil plant at La Plata refinery

ing oil by means of acid treatment and "clay-contact," centrifugal and filter presses for deparaffination, and gasoline plants. These installations, completed in 1935, are all up-to-date, and in the refinery naphtha, kerosene, gas oil, Diesel fuel oil, oils, and greases are processed.

The Compañía Nacional de Petróleo (National Oil Company) owns at Puerto Galván a refinery equipped with topping and Cross units, and here are processed naphtha, kerosene, "agricol" (kerosene for tractors), gas oil, and fuel oil.

In 1930-1931 the Compañía Diadema (Diadem Company) erected in the Dock Sud zone a modern refinery for the processing of oil from its Comodoro Rivadavia fields. This refinery contains six units for primary distillation, with tubular stills operated in parallel. In this refinery are processed naphtha, kerosene, and gas oil. Cracking is done by means of six Dubbs units, one unit being utilized for the reprocessing of naphtha.

The Compañía Itaca S. A. (Itaca Company), which owned a small refinery erected in 1922 at Campana, installed in 1929 near the old plant a new refinery equipped with a Foster-Wheeler topping unit, a Cross topping unit, a processing unit, and a coke plant.

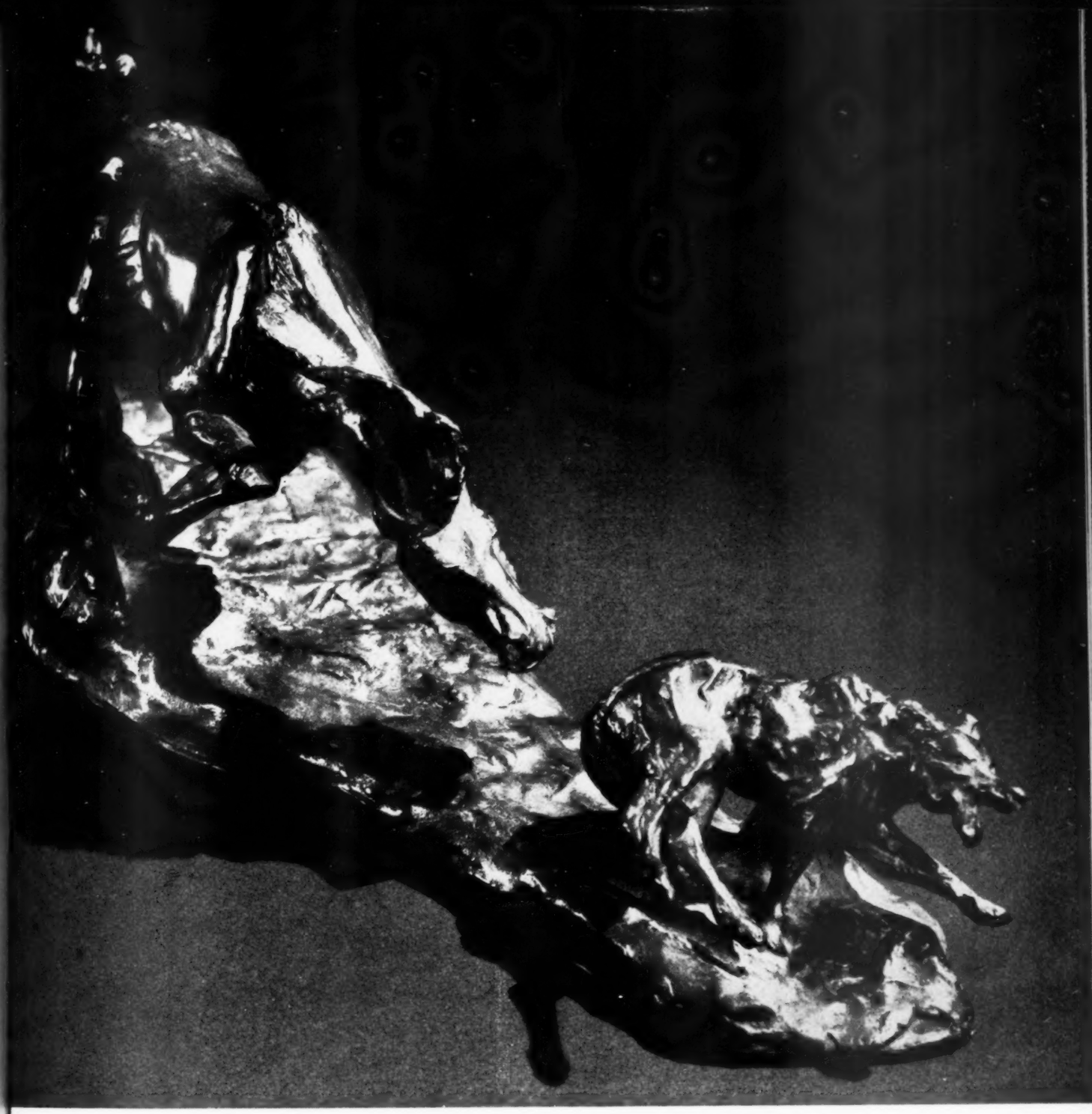
The Compañía Ultramar, Sociedad Anónima Petrolera Argentina (Argentina Ultramar Oil Company), in 1934, installed in the Dock Sud zone a refinery having the latest type of equipment. Lubricating oils are the principal products of this plant, which has the necessary facilities for refining oils of high or low grade. In addition it possesses all equipment necessary for the processing of combustibles, such as a topping and distillation plant with

TABLE 2

Oil Refineries in the Argentine Republic

NAME OF COMPANY	Location	Daily Processing Capacity in Cu. Meters	Sources of the Crude	Products Manufactured	Equipment
Yacimientos Petroliferos Fiscales	La Plata	3,000	Comodoro Rivadavia Plaza Huincul Salta	Combustibles, Lubricants, Wax, Asphalts, Insecticides and Solvents	Modern
Compañia N. de Petróleos (Standard Oil of N. J.)	Campana	1,700	Salta and Imported	Combustibles, Lubricants Asphalts, Insecticides and Solvents	Modern[1]
Compañía Diadema Argentina	Dock Sud	1,600	Comodoro Rivadavia	Combustibles	Modern
Compañía Ferrocarrilera de Petróleo	C. Rivadavia	1,200	Comodoro Rivadavia	Combustibles	Modern
Compañía Ultramar	Dock Sud	500	Imported	Combustibles and Lubricants	Modern
Compañía Itaca	Campana	800	Comodoro Rivadavia and Imported	Combustibles and Lubricants	Partly Modern
Compañía Astra Argentina	Comodoro Rivadavia	400	Comodoro Rivadavia	Combustibles	Old
Compañía N. de Petróleos (Standard Oil of N. J.)	Bahía Blanca (Pto. Galván)	320	Plaza Huincul	Combustibles	Modern
Compañía La Isaura	Bahia Blanca	250	Plaza Huincul and Imported	Combustibles	Partly Modern
Compañía El Cóndor	Avellaneda	250	Imported	Combustibles, heavy oils	Partly Modern
Standard Oil Co. S.A.	Elordi	80	Salta	Combustibles	Old
Yacimientos Petrolíferos Fiscales	Vespucio	60	Salta	Combustibles	Old
Yacimientos Petrolíferos Fiscales	Plaza Huincul	60	Plaza Huincul	Combustibles	Partly Modern
Lottero and Papini	Avellaneda	50	Imported	Combustibles	Old
Standard Oil Co. S.A.	Plaza Huincul	20	Plaza Huincul	Combustibles	"
La Petrolera Argentina	Avellaneda	15	Imported	Combustibles	"
Compañía Petrolífera Andina	Sosneado (Mendoza)	15	Sosneado (Mendoza)	Heavy Oils and Asphalt	Modern
Pedro Roth y Cía.	Wilde	20	Imported (fuel oil)	Lubricants	Modern
	Total	10,310			

[1]The oil and combustibles plant has been rebuilt. It was destroyed by fire August, 1934.



†"THE RANGE FATHER"—by Charles M. Russell

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†*Charles M. Russell had the rare ability to leave an accurate and artistic record of the life of animals. In this bronze, a stallion is protecting the mares and colts from wolves or coyotes. These proud fathers were always on the lookout, and wolves were not allowed to get near the herd.* ☆ *This is the first time that permission has been granted for the reproduction of this bronze. A reproduction of this picture, suitable for framing, is available upon request.*

AXELSON PUMPS AND SUCKER RODS

Lummus tubular stills, together with a De Florez cracking plant, to refine crude oil with the excessive heat obtained from the cracking of the gas oil. For the processing of oils it has a "clay-contact" plant equipped with paper and Sweetland filters and a sulphuric-acid processing plant equipped with Sharples centrifugal units. Deparaffination is done by means of a Sharples plant for heavy oils and a filter press for light oils.

The Compañía La Isaura (Isaura Company) constructed in the vicinity of the city of Bahía Blanca a small refinery with a processing capacity of 100 cu. meters (629 bbl.) daily. The refinery has a topping and a re-distillation plant for the processing of naphtha, ordinary kerosene, kerosene for tractors, Diesel oil, and fuel oil.

There also are other refineries of lesser importance. In the fields of Plaza Huincul, Y. P. F. has installed a topping plant for processing naphtha, gas oil, Diesel oil, and fuel oil. A similar plant also is owned by the Y. P. F. at Salta. This plant processes naphtha, gas oil, and fuel oil. The Standard Oil Company has erected in Elordi (Salta) a refinery equipped with a continuous topping plant having five stills and processing daily 80 cu. meters (503 bbl.) of petroleum and producing naphtha, kerosene, and fuel oil. There are numerous privately-owned refineries, but their capacity is quite small.

Complete data covering refineries in the Argentine Republic are given in Table 2, showing their location, sources of oil supply, the products manufactured, and the various types of equipment in the plants. Their total daily capacity, as can be seen, is 10,310 cu. meters (64,850 bbl.) of crude.

During 1937 the capacity of refineries in the Argentine Republic will be considerably enlarged. New plants already are under construction, and in April Y. P. F. placed in operation a new refinery at Godoy Cruz (Mendoza).

This plant has a daily capacity of 200 cu. meters (1258 bbl.) of crude oil, and produces naphtha and other derivatives in sufficient quantities to supply the needs of the western part of the country.

In its refinery at La Plata, this department of the Government is erecting a new unit, which will begin operations about the middle of the year. The daily capacity of this new unit will be 1500 cu. meters (10,435 bbl.) of crude oil, which will come from its Comodoro Rivadavia fields. It will be a modern plant, processing naphtha, agricol (tractor kerosene), gas oil, and fuel oil.

The Y. P. F. also is erecting a plant for processing by the sulphuric acid and "clay-contact" methods. This plant will be placed in operation during the year.

The same department of the Government has begun the construction of a new refinery at San Lorenzo (Santa Fe), which will be in operation toward the end of the year. This plant will be constructed in such a manner that it later can be enlarged to handle the constantly increasing crude oil production of the country. It will begin operations with an Alco topping unit, cracking equipment, gas recovery and naphtha processing plant, and will have a daily capacity of 1500 cu. meters (10,435 bbl.) of crude that will come from Comodoro Rivadavia fields.

These new installations, together with the refineries now in operation, will provide a sufficient output of oil products to supply the present and future domestic needs of the Argentine Republic.

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J. F. (Bud) Ledbetter — Probably most famous of early Oklahoma peace officers

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It was during territorial days, when Eastern Oklahoma, then Indian Territory, was "wild and woolly", that the late J. F. (Bud) Ledbetter began his career as a peace officer. He was perhaps the most famous of a small group of federal marshals who pioneered the enforcement of law and order in Indian Territory.

Although Ledbetter shot it out, on numerous occasions, with the Territory's most desperate killers, he was never wounded, due to the fact that he had nerves of steel, was a dead shot, and was quick on the draw. On one occasion he quelled a riot single handed. With 5 men shooting at him he killed 4 instantly with five shots from his revolver. Ledbetter died recently at the age of 84.

In 1880, when law enforcement in Oklahoma was in its infancy, J. F. Ledbetter began his brilliant career as a peace officer by declaring "open season" on all Oklahoma outlaws. From the time that he began "specializing" on outlaws, Ledbetter always "got his man."

Specialization by a wire rope manufacturer also gets results. The leadership of UNION Wire Lines, today, is based on the fact that they are built by Oil men to meet the special requirements of Oil field service.

The photo shows Well No. 1 on Phillips Petroleum Company's "Liberty Lease," Oklahoma City field. Left to right, front row are: L. P. Nixon, salesman, and Hal R. Gruber, vice-president and sales manager, Union Wire Rope Corp.; M. G. Ensinger, president and general manager, Union Wire Rope Corp.; T. J. Hamilton and Scott Watson, Phillips Petroleum Co. Middle row: H. S. Kelly, Klint Moore, Frank Willibrant. Back row: L. A. Barlow, J. F. Sparks,—last five all with Phillips Petroleum Co.

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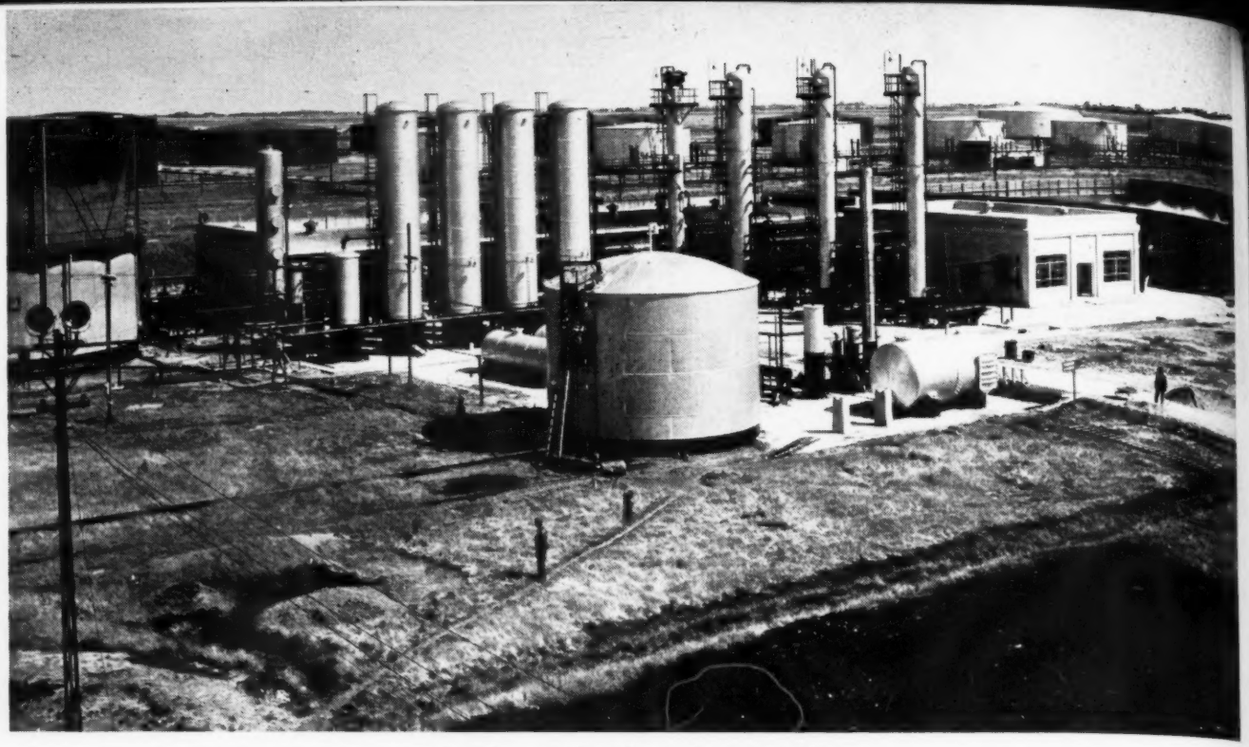
UNION WIRE LINES

The "ULTIMATE LOW COST WIRE ROPE"



Gasoline and liquid gas plant at La Plata

Natural Gasoline Manufacturing Methods in the Argentine Republic

THE manufacture of natural gasoline was begun in Argentina in 1922, when a charcoal absorption-type gasoline plant was installed by Y.P.F. in the Comodoro Rivadavia area.

At the present time modern gasoline plants are in operation in the Comodoro Rivadavia, Plaza Huincul, and Salta fields, owned by the Government and by private companies. The gas treated in these plants contains hydrocarbons in sufficient quantities for commercial purposes.

The Y.P.F. and the Compañía Ferrocarrilera de Petróleo (Railroad Oil Company) have installed absorption-type gasoline plants in Comodoro Rivadavia, and the Astra Compañía Argentina de Petróleos (Astra Argentine Oil Company) owns a charcoal-type plant.

In the Government's plant all the pentanes and higher constituents are extracted from the gas, as well as 70 percent of the butanes, and 16 percent of the propanes. This plant has a daily capacity of 350,000 cu. meters (approximately 12½ million cu. ft.) of gas, and its operation, in general, is as follows:

The gas from the field is processed at a central plant, where the gas is passed through a separator and absorbers. The condensed vapors in the separator are sent to the evaporating tower. From the bottom of the absorbers, which operate at 3.7 kg./cm.^{2} (53 lb./sq. in.), the fat oil passes to the evaporation tower. The residue gas is removed from the upper part of the absorbers, and is used in the field for drilling and production operations.

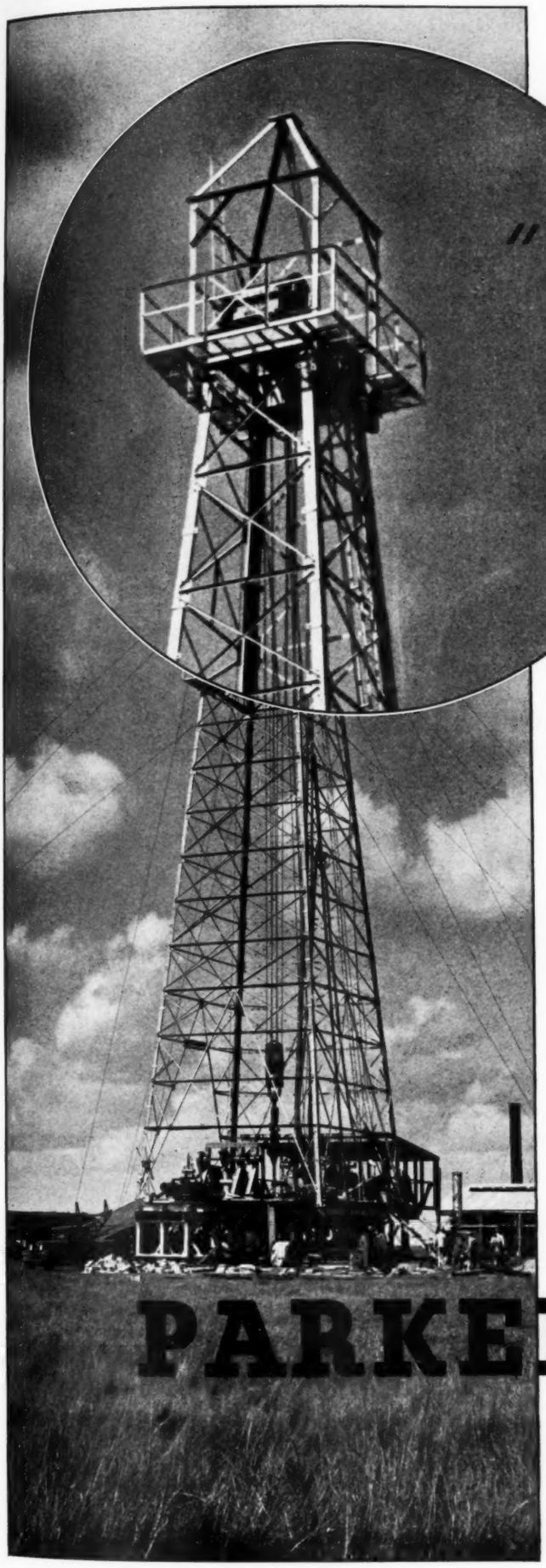
Natural gasoline was first manufactured in Argentina in 1922 when Y.P.F. erected a plant in the Comodoro Rivadavia area—numerous plants now are in operation, owned by the government and by private interests

Vapors from the gasoline and from the super gas that comes out through the upper part are condensed to 21 kg./cm.^{2} (299 lb./sq. in.), then sent to a propane tower where they are kept at a pressure of 20 kg./cm.^{2} (284 lb./sq. in.) and a temperature of approximately 150 deg. cent., and are separated from the oil in the evaporating tower. In the propane tower fixed gases eliminated through the upper part are separated and the gasoline and super gas extracted from the bottom pass to a butane tower, where they are maintained at a pressure of eight kg./cm.^{2} (114 lb./sq. in.). In this tower the separation of gasoline and super gas takes place. The vapors of the latter pass through condensers and are sent to the storage tanks. The manufactured gasoline drawn from the bottom of the tower also is sent to the storage tanks.

Any lean oil from the evaporating tower is pumped back again for reprocessing. This is done after denuding it of whatever gasoline it may have retained.

The Y.P.F. has installed a modern gasoline plant in the Plaza Huincul area; in this zone there are other plants, installed by the Compañías Astra Argentinas de Petróleo (Argentine Astra Oil Companies). The Y.P.F. plant is of the oil-absorption type and the Astra plants are of the charcoal-absorption type.

The Y.P.F. plant has a daily capacity of 70,000 cu. meters (approxi-



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Now, because of growing popularity, the Pyramid Type Gin Pole is offered as standard on all Parkersburg 122′ and 136′ Drilling Derricks. Moreover this premium feature has been added at no increase in price. Thus, in both appearance and value, they are definitely the outstanding derricks in their class.

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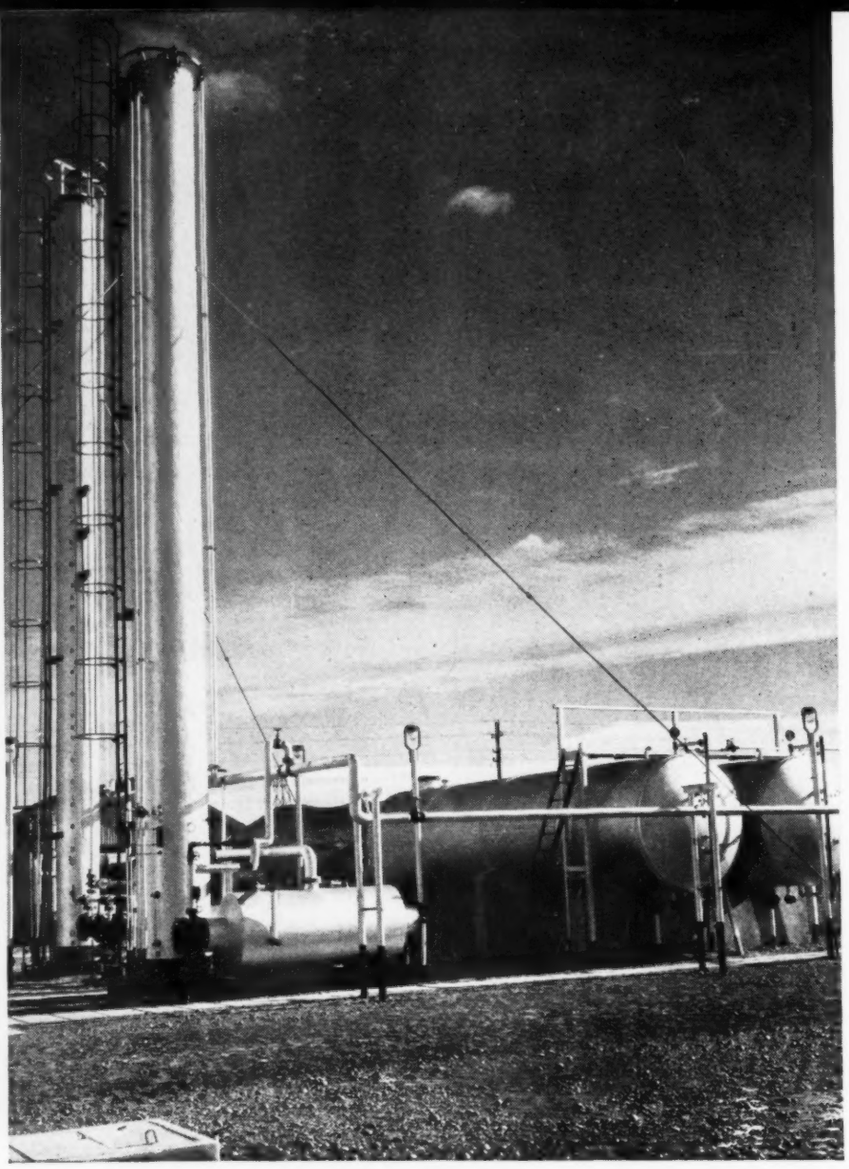

Stabilizing tower and gasoline and liquid gas storage tanks at the gasoline plant in Comodoro Rivadavia zone

mately 2½ million cu. ft.) of gas, being able to extract in the form of gasoline all hydrocarbons contained in the gas.

It has a central plant that takes the gas from the field at a pressure of 3.2 kg./cm.^{2} (46 lb./sq. in.). This gas, after being cooled, passes through a separator and is then sent to the absorbers, where the hydrocarbons are extracted. The residue gas passes out through the upper part of the absorbers and is used in field operations.

Absorption oil is pumped through the tower counter-currently to the incoming gas, and then passes out through the bottom of the tower, well saturated with soluble gases, and is taken to a ventilation tank operating at a pressure of approximately 0.35 kg./cm.^{2} (5 lb./sq. in.). Here the gases not condensed are separated and returned for reprocessing. From the bottom of this ventilation tank the fat oil, after being heated, is pumped through the evaporation tower. Here it is denuded, the vapors absorbed, and after being condensed go out through the upper part of the tower to a production tank. The lean oil, which leaves the tower at the bottom, goes back to the absorbers to begin another cycle.

In order that the gasoline manufactured may always maintain uniform vapor tension not greater than one kg./cm.^{2} (14 lb./sq. in.) at 30 deg. cent. it is subjected to a stabilizing process, the light substances being separated from the gasoline. The manufactured gasoline is stored in tanks operating at a pressure of one kg./cm.^{2} (14 lb./sq. in.), and all vapors resulting from excessive pressure due to the high temperature are absorbed by the central compression plant, together with the vapors from the stabilizing tower.

The manufacture of natural gasoline by the Y.P.F. in the Salta region is done with plants of the charcoal-absorption type. The plant installed in this area has a daily capacity of 35,000 cu. meters (approximately 1¼ million cu. ft.) and operates in the following manner:

Gas from the field is piped to a central plant where a pressure of approximately 3.5 kg./cm.^{2} (50 lb./sq. in.) is maintained. After being cooled, it is passed through a separator, whence it is passed through charcoal-filled absorbers. The duration of the cycles in the absorbers is 25 minutes, the final temperature of the absorption cycle being 58 deg. cent., and the final temperature of the refining cycle 150 deg. centigrade. The residue gas upon leaving the absorbers passes through a separator, and after being cooled, goes to the field for use there.

Once the charcoal is saturated with gasoline constituents, it is injected into the re-heated absorber at a pressure of six kg./cm.^{2} (85 lb./sq. in.) and at a temperature of 240 deg. centigrade. This induces refining of the gasoline vapors absorbed by the carbon. These vapors, now at a pressure of approximately 1.75 kg./cm.^{2} (25 lb./sq. in.), pass through the refrigerator, where the gasoline is condensed, being sent to the storage tanks after passing through a separator where the fixed gases separate from the gasoline and pass out through the top. These gases, together with the vapors produced in the storage tanks, due to the high degree of the surrounding temperature, are absorbed by the condensing plant and reprocessed. The amount of natural gasoline manufactured by the Government and by privately-owned plants is as follows:

COMODORO RIVADAVIA FIELDS

	Natural Gas Processed in cu. meters[1]	Gasoline Recovery in Liters[2]
Comodoro Rivadavia Fields		
Y. P. F.	59,320,664	13,502,962
Astra Cía. Argentina de Petróleo	199,500	1,505
Compañía Ferrocarrilera	125,387,000	460,210
Diadema Argentina	10,152,219	699,000
Yacimiento de Plaza Huincul		
Yacimientos Petrolíferos Fiscales	12,735,518	1,806,275
Astra Cía. Argentina de Petróleo	2,516,700	361,367
Standard Oil Company	14,000,000	1,296,369
Yacimientos de Salta		
Yacimientos Petrolíferos Fiscales	9,263,626	1,433,067
Standard Oil Company	49,099,348	10,403,967

[1]One cubic meter = 35.31 cu. ft.
[2]One liter = .2462 gal. (U. S.)

You are paying for it . . . why not get it?

PRIOR to the building of a plant for the manufacture of JELOX, all of the well-known areas where bentonite is found were carefully checked to determine the location of the best quality of bentonite for drilling mud purposes. The quality of JELOX is proof of the thoroughness of this search. In the JELOX plant scientifically controlled driers, and modern grinding, screening and air-separating equipment turn bentonite into the finished jell mud product which is so readily winning the acclaim of the field.

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IT IS NOT NECESSARY TO "COOK" JeloX

Terminal and wharf at Comodoro Rivadavia

Tanker Transportation of Argentine Government Oil Fields

During 1936 tankers and other boats operated by Y.P.F. transported 1,574,528,460 tons of heavy products and 384,041,877 cu. meters (2,415,508,194 bbl.) of light products

THE Y.P.F. owns a fleet of shiptankers and other smaller vessels, the names and the capacity of which are given below:

OIL TANKERS:	*Tons*
13 de Diciembre	10,052
Ministro Frers	9,972
Florentino Ameghino	8,328
12 de Octubre	8,221
Santa Cruz	4,650
Ministro Lobos	5,220
Ing. L. A. Huergo	4,330
Aristóbulo del Valle	3,170
San Matías	6,860
Figueroa Alcorta	2,400
San Jorge	10,500
	73,703
WATER TANKERS:	
Y.P.F. No. 11	940
Y.P.F. No. 12	560
Y.P.F. No. 13	560
	2,060
GENERAL FREIGHTERS:	
Y.P.F. No. 1	250
Y.P.F. No. 2	250
Y.P.F. No. 3	250
Y.P.F. No. 4	250
Y.P.F. No. 5	230
Y.P.F. No. 6	230
Y.P.F. No. 7	240
	1,700

TUG BOATS:

Atlántico
Almirante Irizar
Santa Lucía

The first oil shipments from the Comodoro Rivadavia zone were made in 1914, via the tankers *Wanetta*, leased from a private firm, and *Ministro Escurra*, property of the Navy Department.

From 1914 to 1921, when the tanker fleet passed from the Navy Department to the Y.P.F. transportation was by means of the two boats just mentioned, and by the transports *Aristóbulo del Valle*, *Ing. L. Huergo*, *Astra*, and *12 de Octubre*.

In 1922 the tanker *Santa Cruz* was added, and between 1923 and 1931 the *Ministro Lobos*, *Florentino Ameghino*, *Ministro Frers*, and *13 de Diciembre* were acquired.

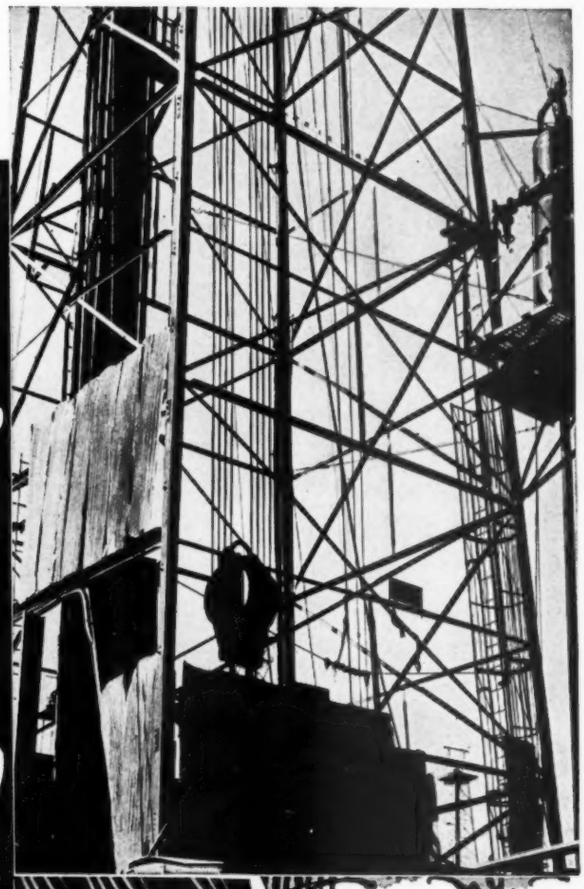
In 1937 the tankers *San Matías* and the *José Figueroa Alcorta* were added, the latter being used exclusively as a river boat, particularly for the transportation of crude from Formosa to the San Lorenzo and La Plata refineries. This latter ship was built in the San Fernando, Argentina, shipyards, and was the first ship of such tonnage built in the country and the first in South America.

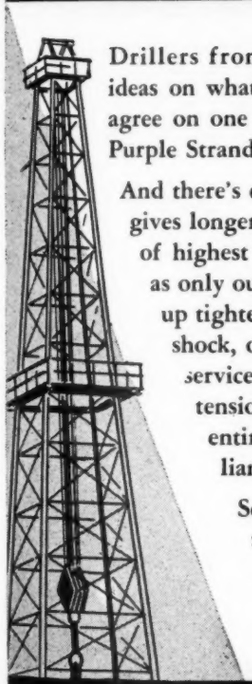
The increase in production of crude oil made it necessary to ask for bids for the construction of a new tanker with a displacement of 10,500 tons. This tanker is now under construction in the Blohm-Voss-Hamburgh shipyards, and will be added to the Y.P.F. fleet the early part of 1938.

The other smaller transports, water tankers, freight boats, and tugboats were acquired between 1923 and 1931 by Y.P.F. and made a part of its fleet.

One place where most Oilmen agree:

WILLIAMSPORT PURPLE STRAND "Form-Set" gives longer service!



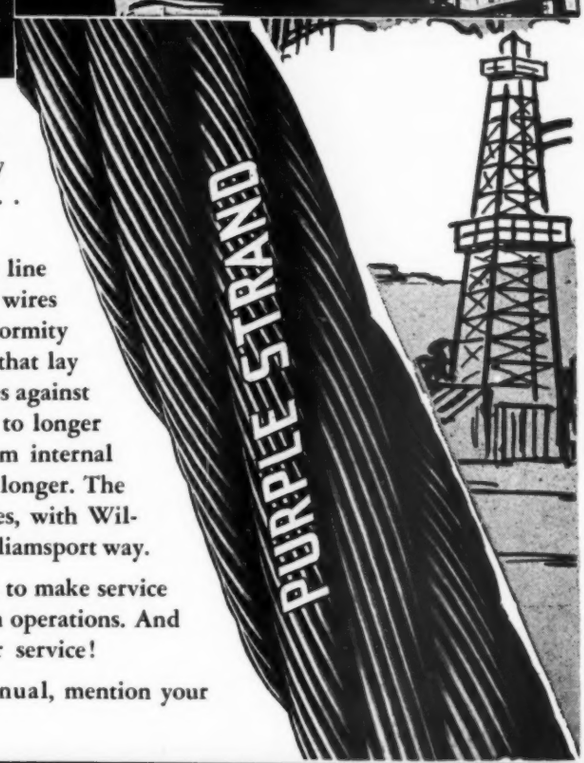


Drillers from different fields often have different ideas on what handles a job best. But they generally agree on one line for service in rotary drilling . . . Purple Strand "Form-Set."

And there's every reason why this ace Williamsport line gives longer, more reliable service. It is made with wires of highest tensile strength, drawn to precise uniformity as only our Carboloy dies can draw them; wires that lay up tighter and seat more firmly. Cushioning wires against shock, our exclusive Uni-Zact core contributes to longer service. And because it is *pre*formed free from internal tension, "Form-Set" works better and wears longer. The entire line is built in Williamsport factories, with Williamsport accuracy, and *pre*formed the Williamsport way.

See how Purple Strand "Form-Set" helps to make service records . . . watch this line on your own operations. And remember: Williamsport gives longer service!

In sending for your Wire Line Manual, mention your equipment.



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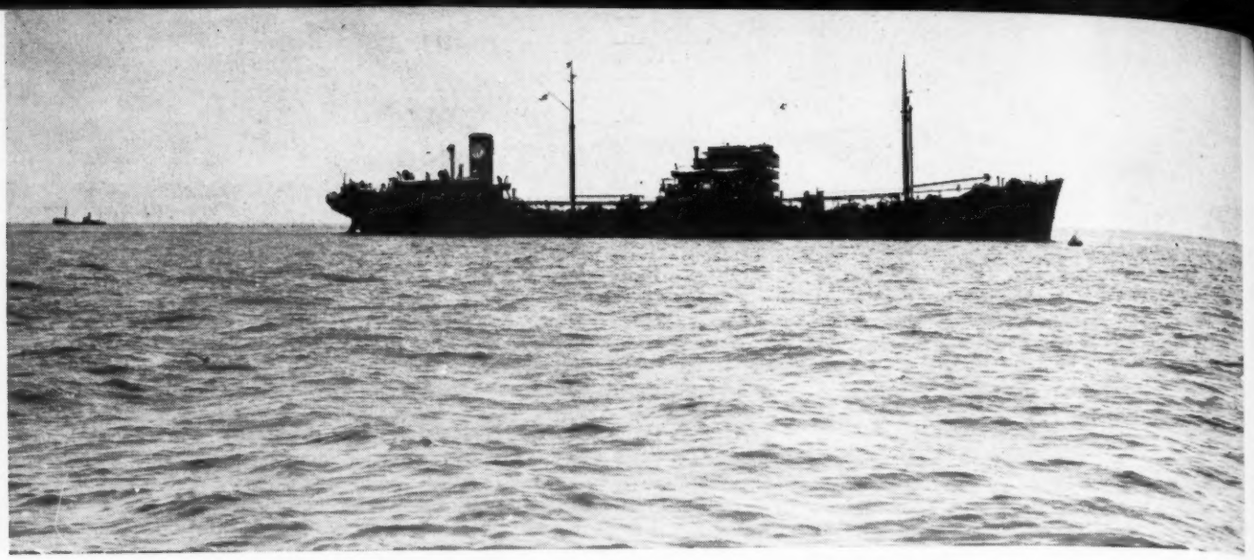


Tanker "13 de Diciembre," the most modern of the Y.P.F. fleet

During the year 1936 the tankers and other boats transported 1,574,-528,460 tons of heavy products and 384,041,877 cu. meters of light products.

It is of noticeable importance to observe that Y.P.F., besides using its fleet of tankers for the transportation of crude between the oil fields and the refineries and for the transportation of by-products from the refineries to the river and sea storage and distribution centers, it gets even greater service from its ships. Ships equipped with accommodations for passengers are employed to cover the distance between Buenos Aires and Comodoro Rivadavia (an approximate distance of 1000 nautical miles), the bulk of passenger traffic consisting of employees from Y.P.F. and their families, military units stationed at Comodoro Rivadavia, school teachers, and other National employees. During 1936 some 4,361 passages were issued.

Materials required by the oil industry at Comodoro Rivadavia are conveyed by the tankers. This practice also applies to the transportation of food products for the sustenance of the Y.P.F. forces, in this manner supplying the residents of the area and their families with food at a reasonable price.

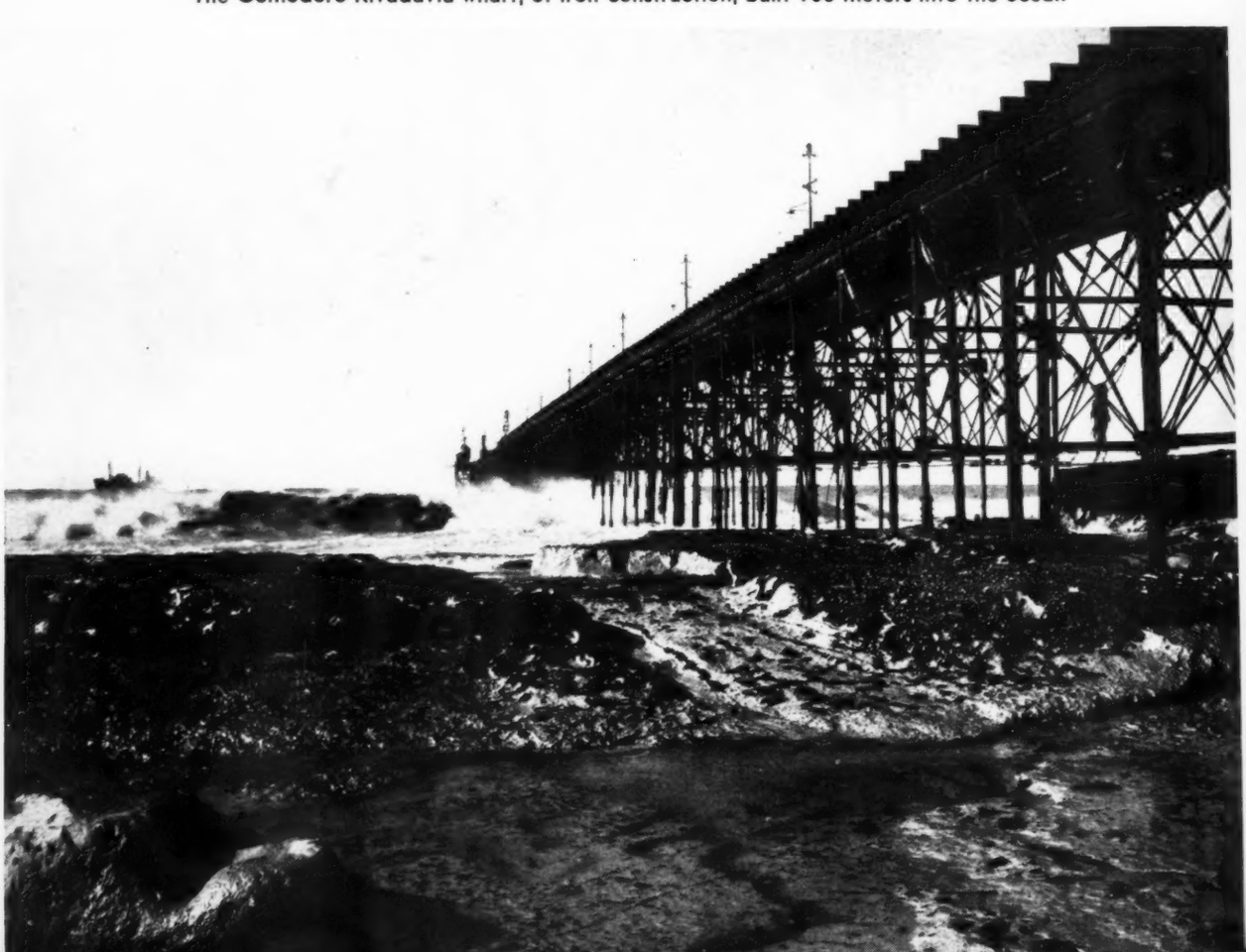
In 1936 there were 61,439,215 tons of this class of freight transported by the Y.P.F. fleet.

Instead of using the railroads, Y.P.F. conveys its canned and bottled by-products from the refineries to storage by means of its own tankers.

The movement of the fleet is assisted by the three tugboats it owns. The same service is performed by the tugboats when the water tankers are to be transported on to the Paraná and Uruguay rivers.

The seven freight launches for dry freight care for the needs of the Buenos Aires and La Plata harbors as it pertains to the receiving of Y.P.F. products from across the sea, which they transfer from foreign ships to local ships-tankers or wagons (cars). This represents an auxiliary service of great importance, which in 1936 transported 27,559,346 tons of freight.

The Comodoro Rivadavia wharf, of iron construction, built 900 meters into the ocean



Trinidad Development Offers Interesting Prospects[1]

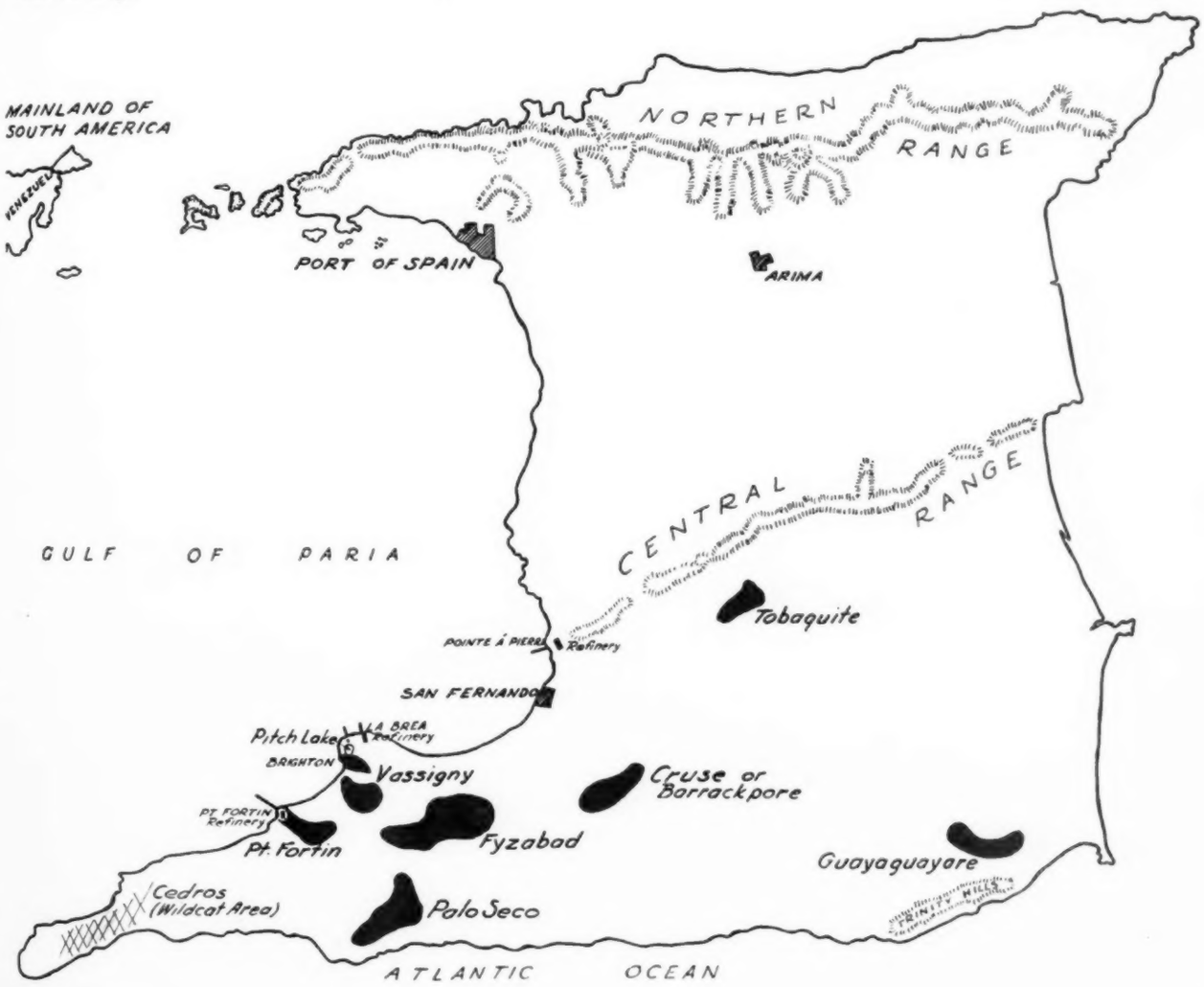
Deep drilling on a larger scale than in the past seems in the offing—heavy equipment will be necessary on many of the wells

ALTHOUGH the island of Trinidad is producing less than 40,000 bbl. of oil daily, there are at the present time approximately 40 strings of rotary tools actually drilling. This means that there is one rig for every 1000 bbl. of oil being produced—compare this with such areas as Venezuela where there is probably only one drilling well for approximately every 10,000 bbl. of production. Despite this fact, there is every indication that deep drilling will be carried on to a greater extent than in the past and that heavier equipment will be necessary for efficient operations in many of the future wells.

The pressures encountered in the deeper zone are of particular interest. Even at shallow depths, however, the formation pressure frequently is abnormally high, one well at a depth of only 3300 ft. having a bottom-hole pressure of 2600 lb. per sq. inch. In a well producing from approximately 7000 ft., the pressure was found to be 5200 lb. per sq. inch. Although these probably are extreme cases, there have been many instances where mud weigh-

[1]Any conclusions drawn are those of the author and are based on data obtained from a number of different sources. This article aims to present a general picture of present conditions and to indicate the operating practices being followed.

Fig. 1. Oil producing areas on the Island of Trinidad. These areas are shown exaggerated in order to indicate more clearly their general location and therefore are neither to scale nor accurate in their limits. Some probably will be connected by future drilling.



ing 110 lb. was considered necessary at 2000 feet. In the lower productive zone the pressures are greater than the hydrostatic pressure and it is when striking this zone at such shallow depths as 2000 ft. that the excessive pressures are encountered.

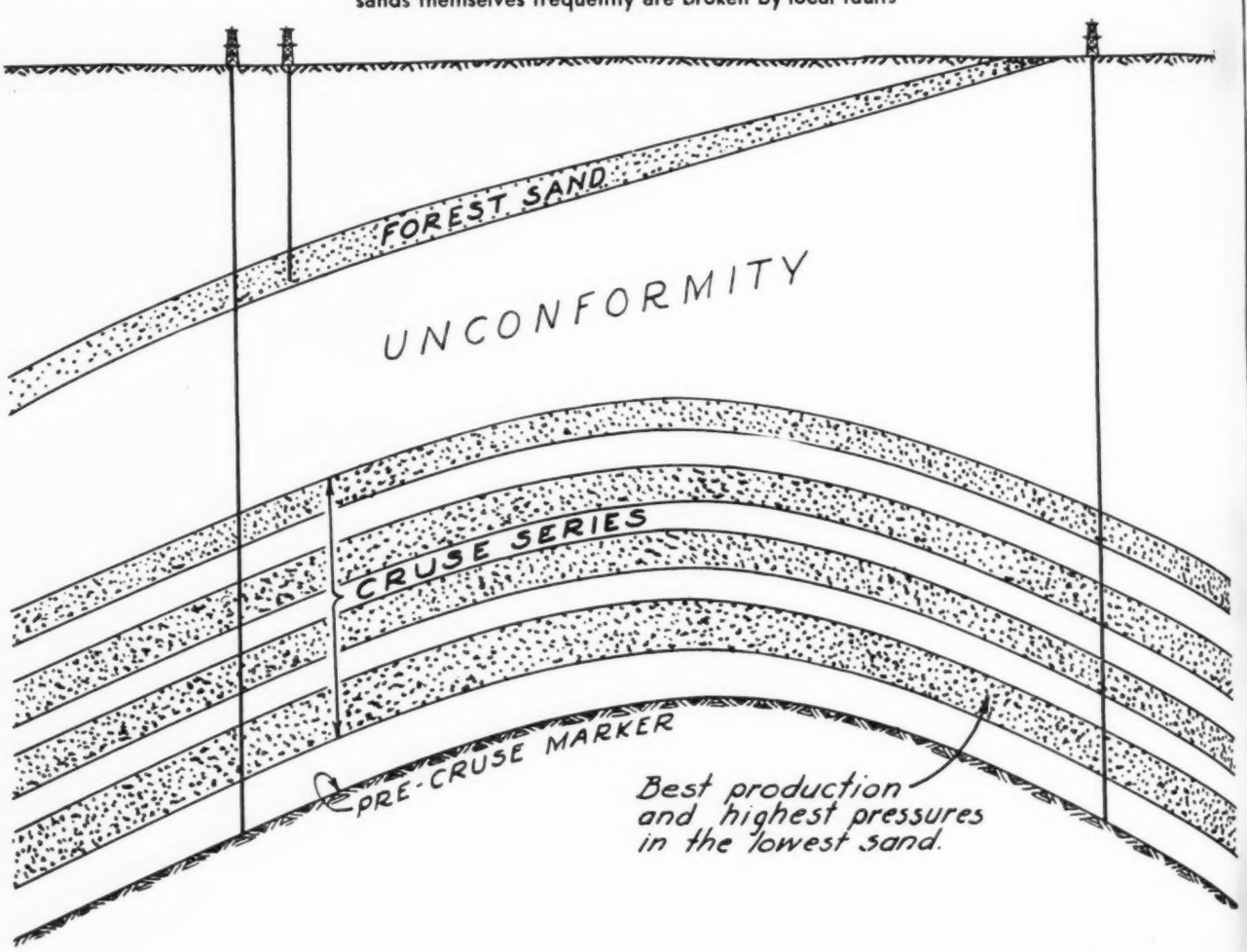
At present, production is from an upper sand called the Forest and from a series of sands in a lower zone called the Cruse. Between the Forest and the Cruse formations there is more or less unconformity throughout the various present producing areas on the island. The structures are anticlinal but become lenticular; they are individually faulted and the sands throughout the entire area are faulted. There is no typical section that illustrates conditions but Fig. 2 shows in general what may be encountered. The Forest zone is shown outcropping, but actually it may or may not outcrop in many places.

In addition to local faulting, there appears to be a major fault running east northeasterly and cutting through the northern part of the southern peninsula. This may extend across the Gulf of Paria into Venezuela but it is questionable that it does. At any rate, the wells drilled at Pedernales in Eastern Venezuela are producing from the Cruse zone at depths of approximately 5000 ft.; but those wells drilled into the same zone in Trinidad at locations south of this fault have found production at about the same depth at some places and at greater depths at others.

The Cretaceous recently has been picked up in Trinidad by a well drilled by the Antilles Petroleum Company near Pitch Lake. Cores from this well have been analyzed by two other companies and the formation quite evidently is the Cretaceous. What the prospects are for future production in this formation cannot even be surmised, as there are no other data on its occurrence in the island. It is felt by some that the Cretaceous found has been thrown up somewhat like a salt dome and that there is little prospect for a reservoir. The depth at which the sample was obtained was about 3600 feet.

The oilfields in the island have been designated by a number of names, but for simplicity the productive areas are shown on the accompanying map (Fig. 1) to include all fields that are frequently referred to locally by sectional designation. Forest Reserve for instance has been included with Fyzabad, and the Vassigny area is shown to include Pitch Lake. The lake, however, involves a project that is not here considered as an oil operation. All areas shown on the map are exaggerated in order to give their general location and therefore are neither to scale nor accurate in their limits. The Cedros is a wildcat area of the southwestern end of the general production trend as now discovered. The Tabaquite is a small shallow field on the opposite end. All these fields have a general anticlinal axis running in a somewhat east northeasterly direction. In the southeast corner of the island is the Guayaguay-

Fig. 2. This section shows what subsurface conditions may be encountered in Trinidad. Although the structures are generally anticlinal, they frequently are lenticular; moreover, the productive areas are faulted to varying degrees and the sands themselves frequently are broken by local faults



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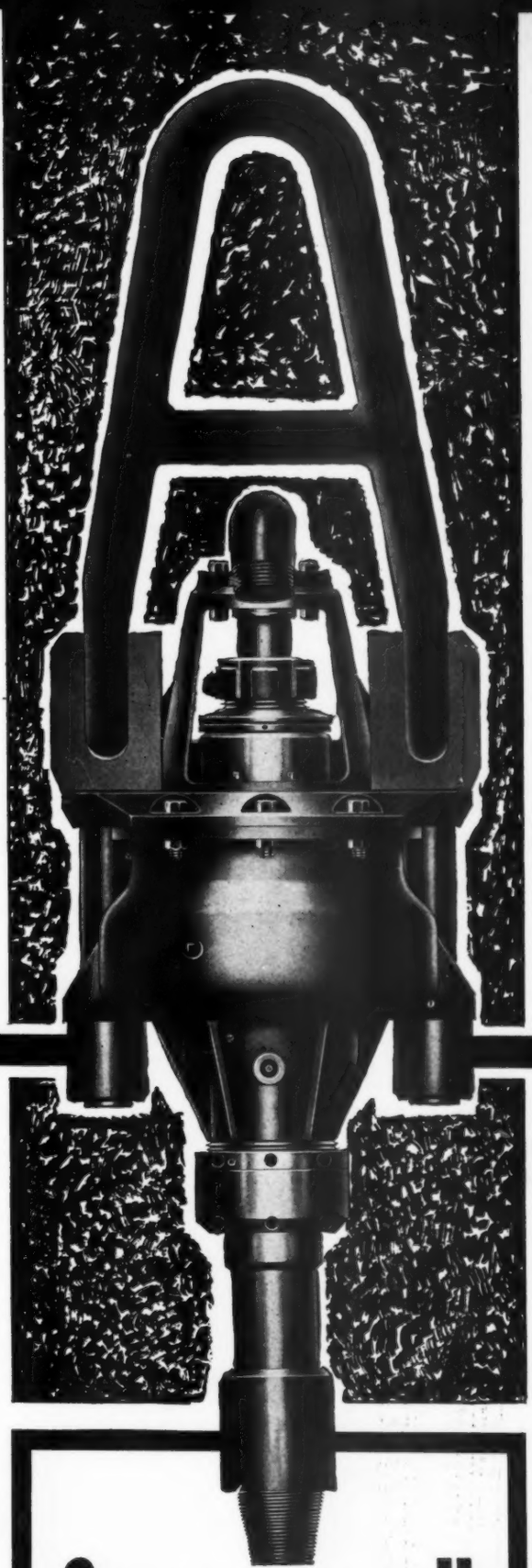

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- ▲ **STRENGTH** in radial bearings sufficient to maintain the degree of alignment necessary to avoid packing troubles.

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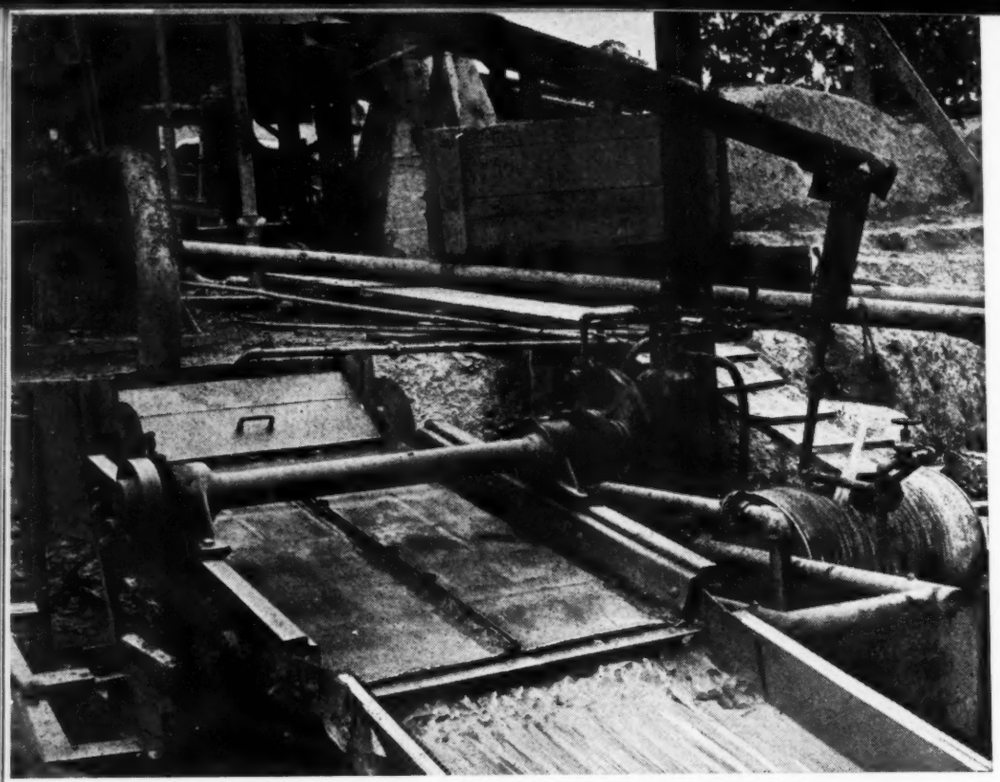


Mud screen on a drilling well in Trinidad

are area where two strings of tools are running.

There is, and has been for sometime, talk of marine drilling in the Gulf of Paria to the northeast of the peninsula and in the Atlantic Ocean to the south. If and when this occurs, the shallow water along the shore of the Gulf probably will permit the application of the drilling technique developed on Lake Maracaibo. Locations on the ocean side, however, where deeper water will be encountered, probably will require different methods and indicate that directional drilling may become advantageous. Such developments are in the future, however, and cannot be predicted at this time. Some marine geology has been done; but how favorable the indications are and what conditions will prevail are still not generally known.

Deeper drilling in existing fields, and probably as extensions to the areas already developed, is reasonably certain in the immediate future. As already mentioned, one well is being drilled, the objective being the Cruse zone, which lies at a depth of approximately 9000 feet. This is in the Fyzabad area. Another well that probably will reach a depth greater than 8000 ft. also is being drilled. The geology for specific areas is well established and there is every possibility of extending the fields or of connecting the present productive areas with wells.

Trinidad has the largest oil-producing area of any British colony. Most of the present oil is being produced by the following companies:

Trinidad Oilfields Operating Company.

United British Oilfields of Trinidad, Ltd.

Antilles Petroleum Company.

Apex (Trinidad) Oilfields, Ltd.

Kern Trinidad Oilfields, Ltd.

New Dome Oilfields, Ltd.

The Trinidad Leaseholds, Ltd.

Trinidad Petroleum Development Company.

Consolidated Oilfields of Trinidad, Ltd.

A few other companies have holdings and some of these probably will procure production in the near future.

Drilling Procedure

The productive zones are the Forest sand, which yields an oil of 13 to 20 deg. A.P.I. at depths ranging from very shallow to as great as 2500 ft.; and the Cruse series of sands, which produce an oil of 19 to 22 deg. A.P.I. at depths generally between 2000 and 4000 feet. All sands are very fine. Where the Cruse sand is found to be deeper, the wells are completed in the same manner as those whose total depth is about 4000 feet.

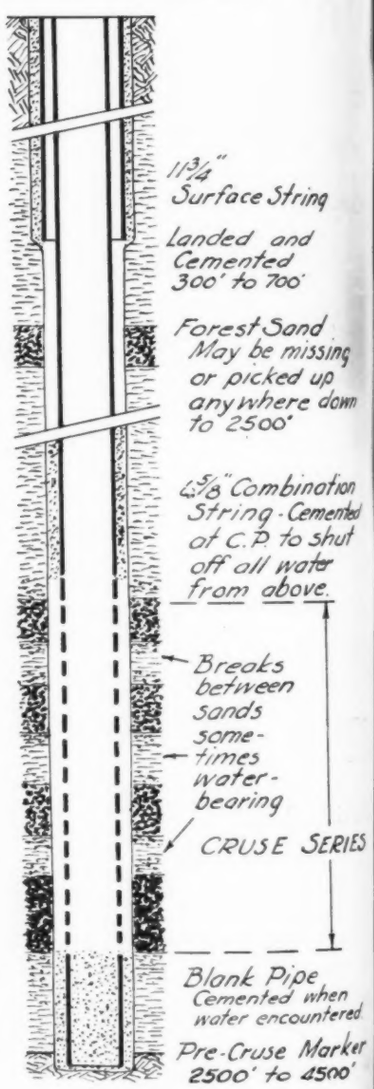
In most instances the Cruse series consists of four sands, which are separated by shale breaks that are sometimes water-bearing. When intermediate water is encountered it therefore must be shut off. The lowest of the Cruse sands is the best and is the one in which the highest pressures are encountered.

The bottom of the lowest Cruse bed is not always certain and wells usually are drilled below this sand until a marker, shown in Fig. 1 as Pre-Cruse, is picked up. This added depth often results in striking bottom water that has to be cemented off. It is becoming general practice with some companies to run a blank section of pipe below the productive depth to facilitate the cementing job if one becomes necessary. Practically all wells are logged electrically and the placement of perforated pipe opposite the producing zone readily is accomplished.

Two of the companies operating in Trinidad have paleontological laboratories and analyses of core samples are made rapidly, both for the companies operating the laboratories and for other companies on the island. A preliminary analysis is made in about an hour and the drilling well is frequently shut down until paleontological data from a core sample is obtained.

Various types of bits are used, but the four-way type probably is most widely used. Surveys for inclination

Fig. 3. This casing program is being followed in general by a number of companies when completing wells in the Cruse zone


11¾" Surface String
Landed and Cemented 300' to 700'
Forest Sand May be missing or picked up anywhere down to 2500'
4½" Combination String - Cemented at C.P. to shut off all water from above.
Breaks between sands sometimes water-bearing
CRUSE SERIES
Blank Pipe Cemented when water encountered
Pre-Cruse Marker 2500' to 4500'

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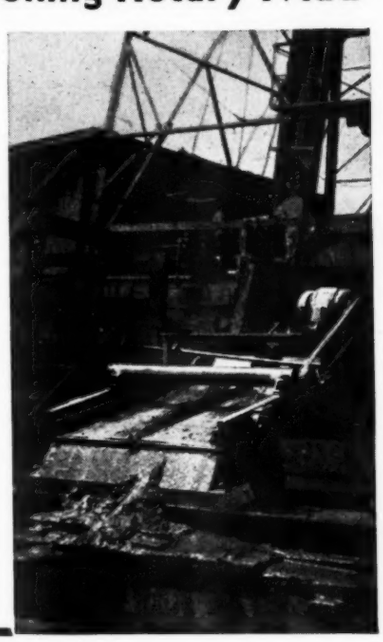

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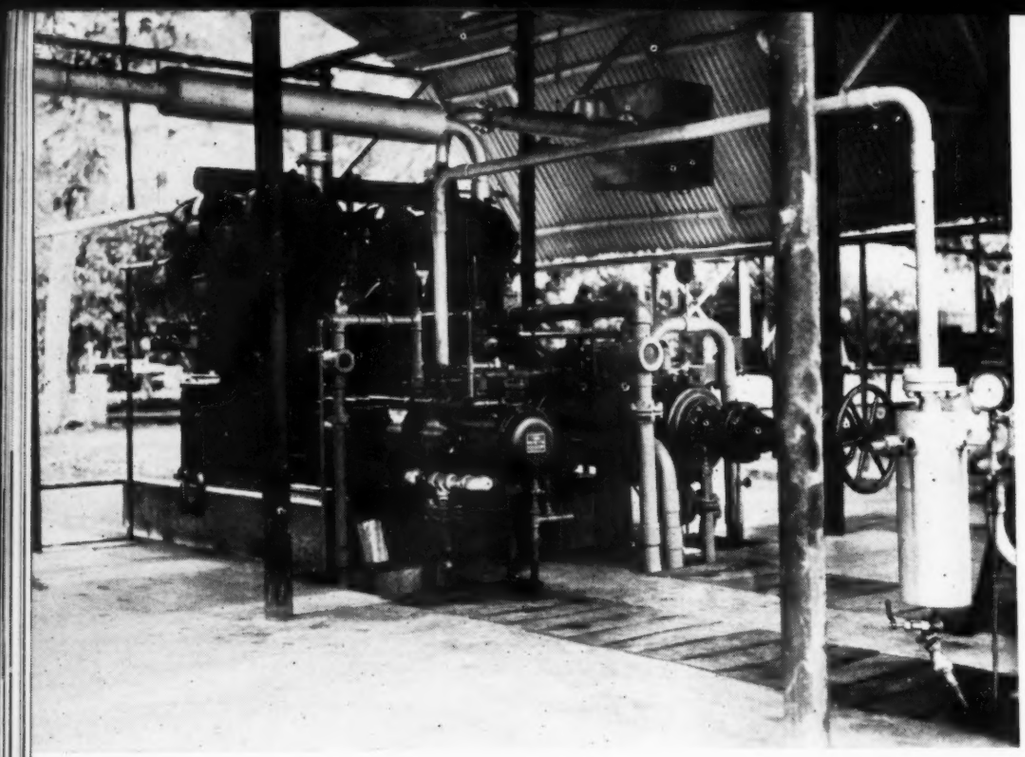


Two new compressors at a compressor station, Trinidad

are made by acid bottle in most wells, although one or two single-shot instruments are in service. Coring is relied upon to supply samples for field examination and laboratory analyses. The shales encountered are soft and somewhat "heaving" in character. They add greatly to the viscosity of the drilling fluid and probably increase the excessive plastering effect that makes the mud problem of considerable importance in the Trinidad wells.

Drilling Mud

Drilling mud is a problem. The high pressures encountered in the Cruse formations are controlled by mud weight exclusively, although most of the companies are using blowout preventers on all wells being drilled into the lower sands. The weight of mud used is generally about 120 lb.; in many instances this is increased to 130 lb. when drilling through the lowest Cruse, and there have been more than one instance where 140-lb. mud has been considered necessary.

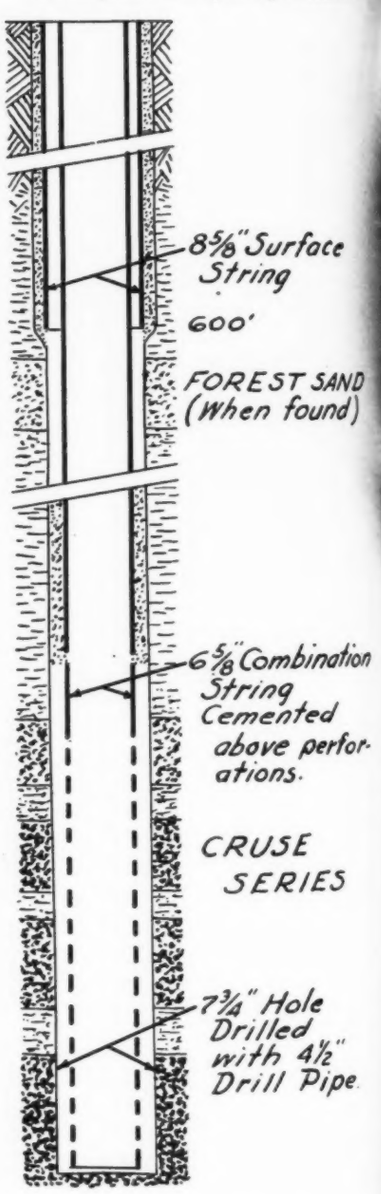
Unfortunately, the plastering effect of the mud is to form a jell-like sheath that is very difficult to remove from the producing sand. The original fluid is made from native clays, one company using a particular character of mud found in a certain area that it controls. Colloidal properties are acquired by the mud as the shales are penetrated; but these particular colloids seem to increase the viscosity excessively. During drilling, the mud is thinned out with a compound composed mainly of tannic acid and sometimes with caustic soda. Many engineers are of the opinion that during completion of the wells the mud fluid in the hole forms a tenacious plaster that is unnecessarily thick. Questionable also is the effectiveness of this mud in the rapid prevention of water infiltration as it plasters the walls of the hole. The problem is being given considerable study at the present time, for there may be a possibility of increasing the well's production by developing a better mud fluid and for removing the mud plaster from the face of the sand more effectively than has been the custom.

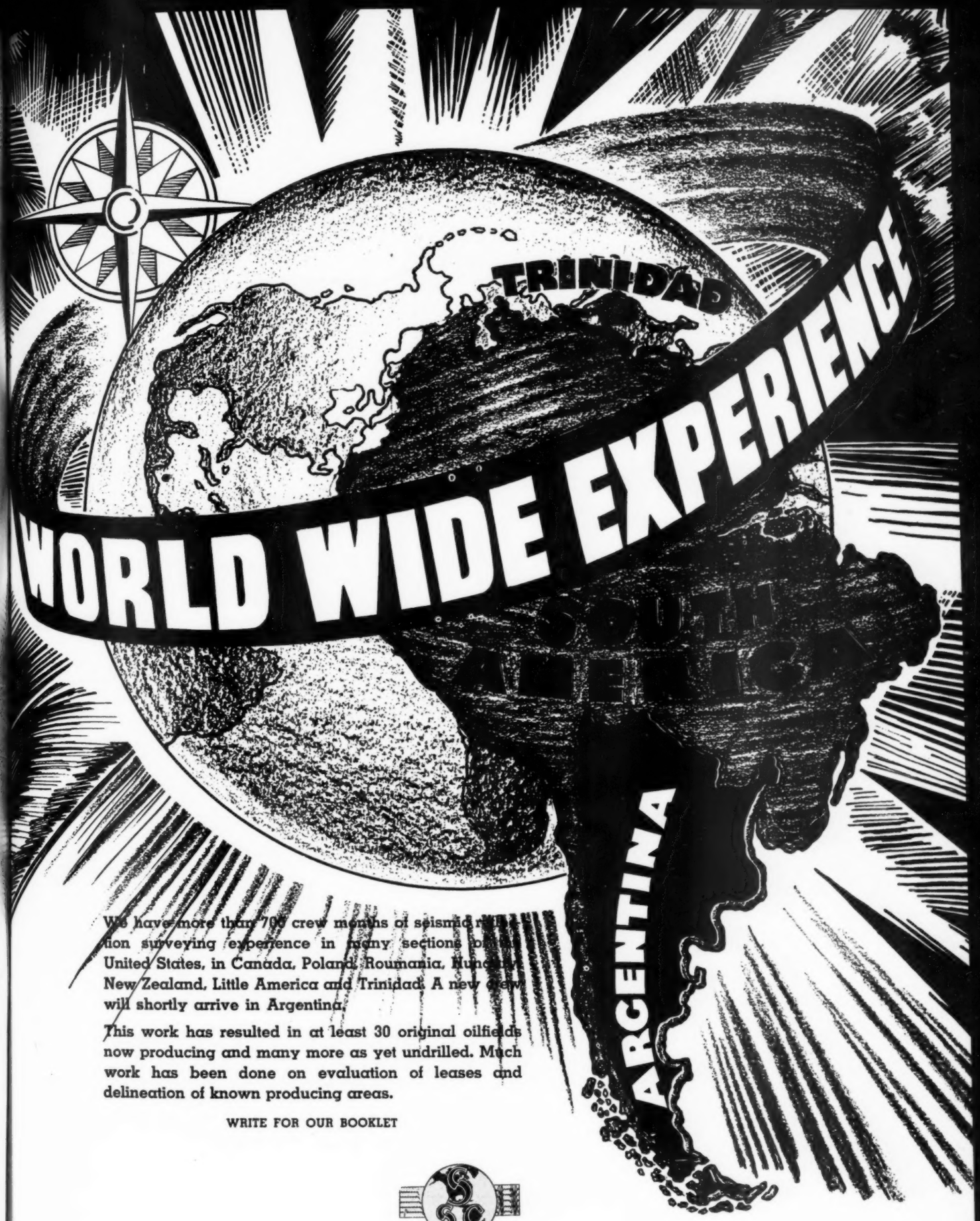
No data are available, however, on the amount of water penetration into the sand while drilling or on the actual thickness of the mud sheath formed. There is a possibility of the mud retarding production, especially in the oil measures of the sand, and letting out more of the gas from the upper portion of a stratum or from upper strata where more than one are productive. This may be a cause of the high oil/gas ratios frequently encountered in some of the wells in spite of the back pressures held. Better mud removal or better mud control might give bigger wells. Vibrating screens now are coming into greater use and may aid in mud control, but such screens are not to be seen on many of the wells now drilling.

Two of the companies have central mud plants. At one they mix the mud of the particular type mentioned above with weight material and pump it to the wells at approximately 110-lb. pressure when drilling is in high pressure zones. The returns are pumped back to the central plant where as much of the weight material is settled out and recovered as possible. At the other central plant the mud is pumped to the wells and the spent mud returned for conditioning and saving of the heavy fluid. When heavier mud is necessary, additional weight material is introduced at the well.

The casing program, indicated in Fig. 3, is somewhat general with all the companies except two. This program may be changed somewhat with the deeper wells now in prospect but its adaption to the deep test now being drilled is indicated by the fact that a 11⅜-in. surface string has been cemented at 1700 ft. and that open hole will be carried to completion, expected at approximately 9000 feet. A combination string, probably 6⅝-in., will then be landed and cemented at the

Fig. 4. One company has used this drilling and casing program with success in spite of the very small clearances provided by the procedure





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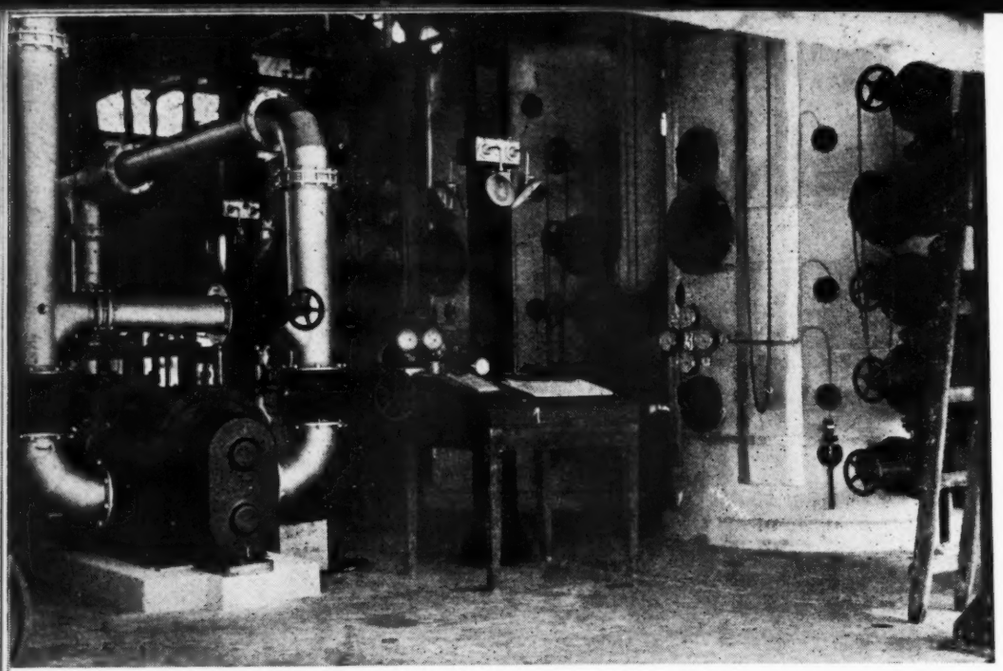


The absorbers in the Apex (Trinidad) Oilfields, Ltd., charcoal plant

combination point, the pipe below being perforated opposite the producing zone.

One company uses liners and with wells of 4000 ft. run and cement a surface string and a water string. In deeper wells it is this company's practice to start with larger hole and run whatever other strings are considered necessary. A rather unusual practice is being followed by another company, as indicated in Fig. 4. The clearances in this method are very small, yet the procedure has been carried on with considerable success.

Cementing

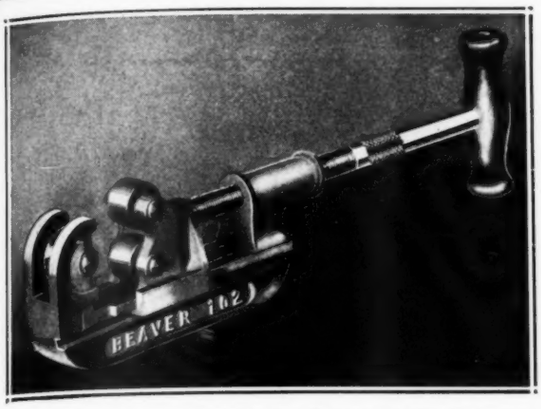
While many special problems arise in the cementing of wells, apparently there has been no particular difficulty in solving them. Such special problems, moreover, are similar to those encountered in every developed oil area. Each demands specific treatment when it involves repair work and the solution generally depends on application of equipment to meet the individual conditions.

The surface string is being cemented by the two plug method by discharge through the shoe. When a water string, or other strings that might be run in deep wells, are cemented the same procedure is followed. As stated, however, all companies except one are using a combination string with the oil section of the string perforated. The upper, blank section of this string is cemented in the usual manner to form a water string above and an oil string below the cementing point. Some companies, however, enlarge the hole for about 20 ft. at and above the cementing point to insure complete encasement of the pipe at this vital point. The hole at the shoe of the surface string also is enlarged in some of the wells before the pipe is run.

Although the method of cementing behind the pipe through the productive zone and then perforating for production has not been followed to any considerable extent, there is a tendency among some operators to do this to a greater extent in the future. The sands are so fine that they come into the perforated pipe rather easily and it is felt that less sanding may be encountered by cementing through the entire Cruse series and then perforating where the electrical log and coring have shown greatest possibilities for oil. By following this method, any intermediate water that may be present also can be shut off at the same time and a repair job eliminated. This alone probably will be an incentive to cement through the Cruse series and gun-perforate for production.

The cement is generally mixed to make a weight of approximately 110 lb. per cu. foot. Frequently, however, it is not much more than 100 pounds.

A triplex hook with heavy elevators shown ready for use



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Blow-out preventer on a drilling well in the Vassigny field, Trinidad

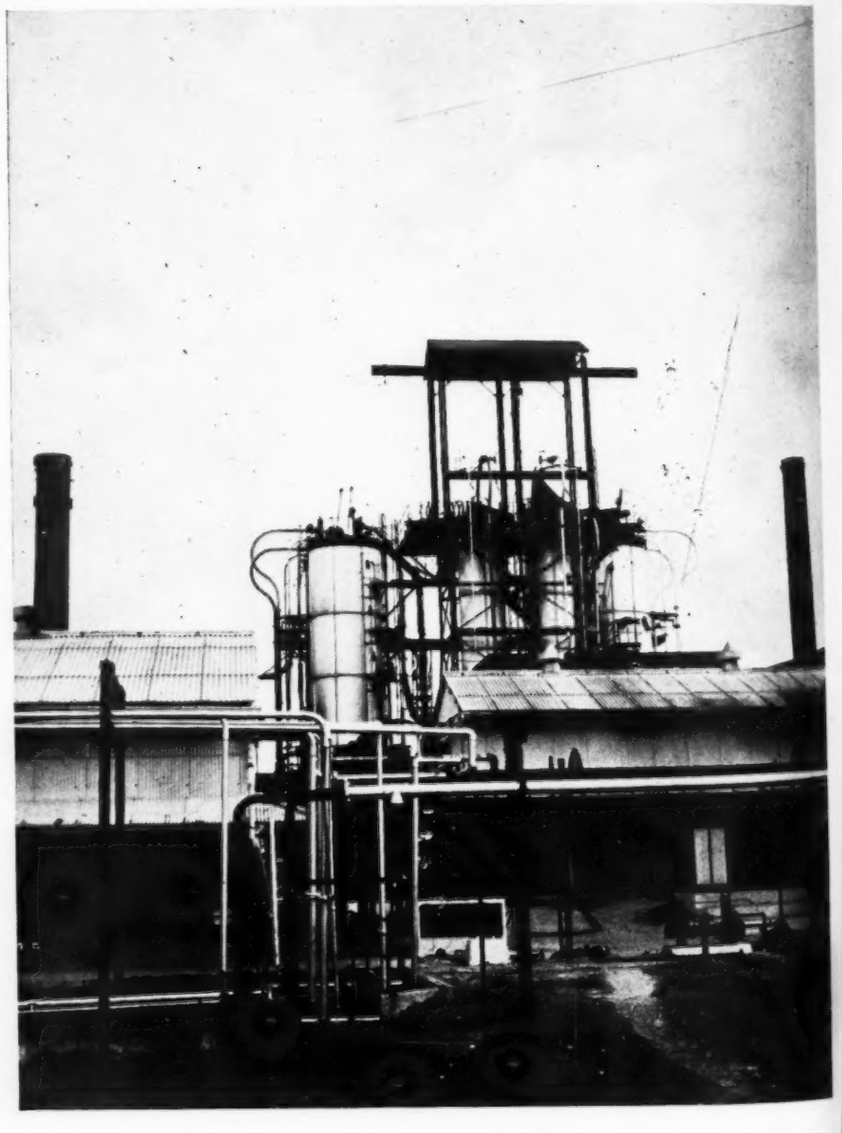
During the cementing of the combination string the hole is full of the heavy mud that may weigh up to 130 pounds. The conditions in which the cement is placed thus are evident. The companies all do their own cementing but a cementing company is now being organized and may take over most of this work. The cement is shipped from England in steel drums and is almost always screened before use. Until recently this screening was done by hand but now several of the operators are employing vibrating screens for the job. The steel drums probably are not as satisfactory as water-tight bags, especially under the climatic conditions.

Surface Equipment

Steel derricks are used universally throughout Trinidad, with concrete foundations, and the modern type of cellar. Since pressure control is by weighted mud and the high-pressure wells are equipped with blowout preventers only, there is no need for deep cellars. With deeper drilling in prospect, however, there may be changes in the control system, although it now appears that very heavy mud still will be relied upon for pressure control.

Rig equipment mostly is of the medium weight type but a number of wells use light equipment. On one of the deep wells now drilling the drawworks is a heavy type driven by a 12 by 12 horizontal engine. The new type of engine-powered rotary unit that drives the table only is in use on one or two wells. Two mud pumps, 14 by 7¼ by 14, are used and in practically all drilling in the Cruse sands the two pumps are compounded. Pump pressures range from 1500 to 1700 lb. in such instances, but sometimes exceed 2000 pounds. Small boilers, 80-hp., are used because of limited road facilities on the island. One company, however, has started to bring in 120-hp. boilers over a route that permits their haulage.

Although no tachometers are in service at present, the rotating speed is approximately 90 r.p.m. in shales and 150 r.p.m. in hard formations. The weight on the bit is governed by weight indicators and recently drilled wells are maintained vertical. Some of the older wells probably are rather crooked but that is no different from



Cracking stills now in service at the Pointe-a-Pierre refinery of the Trinidad Leaseholds, Ltd.

Petty crew and equipment on location in South America

A Seismograph Reflection Shot

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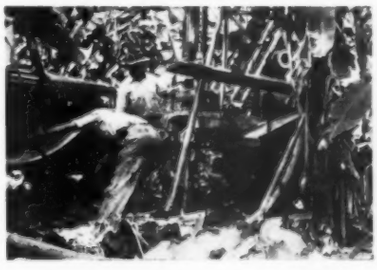

Drilling Shot-Hole in Banana Grove

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Production Methods

Some wells in Trinidad are flowing naturally, some are on gas lift, and others are pumping. The flowing wells are produced through beans and a back pressure is carried on the sand. This excludes the sand as well as reduces the oil/gas ratio. Despite such flow control, however, the oil/gas ratios frequently are higher than operators desire. It is the belief of some that this may be due to inability to remove the mud from the face of the sand completely, as the gas in the higher section of the sand may have broken through the mud plaster more readily and thus attained freer access to the hole than the oil below. As further evidence it is offered that a number of the pumping wells will blow off a head and flow for a short while after they have been off production for a short time.

Pumping wells are pumped by individual units and by central powers. In addition to the gas-engine driven unit there are a number of steam units, such as the one illustrated. This type is used in certain places because of the availability of water and fuel. The pumping device operates in a manner similar to a locomotive cylinder with a trip at the top of each stroke to actuate a valve and allow the rod with the cylinder attached to fall.

The well pumps are of various makes with down-hole conditions influencing the type selected. There also are a number of plunger lift applications that have been found popular under certain conditions.

Repressuring is being done successfully in some instances, the usual procedure being followed for small operations. One company is storing gas and uses three intake wells for the purpose.

In most instances, the oil and gas from the well flow into a separator; from there the oil goes to storage and the gas is taken off for whatever purpose it is intended. There are a few gasoline plants in each area. One of these is a charcoal plant through which is passed 8000 M. cu. ft. daily. The charcoal is cleaned about once a month and the results obtained from the operation of the plant are considered satisfactory.

Separators and field tanks frequently are arranged in "production squares" that are composed of batteries consisting of the number of units necessary to handle the number of wells that can be conveniently flowed to that location. In some instances the tank and separator are placed at the well to form a complete production unit at the one location.

Refineries

The main refining companies are The Trinidad Leaseholds, Ltd., the United British Oilfields of Trinidad, Ltd., and the Trinidad Oilfields Operating Company, Ltd. The Trinidad Lake Asphalt Company, of course, has its refinery at Pitch Lake from which it carries its product via conveyor to a loading pier on the shore of the Gulf of Paria. On this pier also is a pipe line for oil produced in the Vassigny field and through which the oil is loaded into tankers.

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The largest refinery in Trinidad is that of The Trinidad Leaseholds, Ltd., at Pointe-a-Pierre. This consists mainly of three topping plants and cracking units. Oil is pumped to the refinery through a 10-in. line 20 miles in length.

The hot oil from the pipe stills is carried to the fractionating tower where gasoline, kerosene, and one or more grades of gas oil are taken off. The liquid remaining is scrubbed with superheated steam to obtain the desired flashpoint and then pumped through heat exchangers to storage or to the cracking plant. Properties of the gasoline and of the distillate are adjusted by automatic control.

The cracking units are charged with the fuel oil from the topping plant after it is preheated by direct contact with outgoing vapor products. On entering the pipe still the oil is at a temperature of approximately 785 deg. fahr., and is here raised to approximately 1000 deg. fahrenheit. It emerges from the coil under pressure and enters the reaction chambers, the working pressure of which is maintained at 450 lb. per sq. inch.

The cracked oil vapors pass through a fractionating tower and are separated into two fractions differing in volatility. The lighter passes out the dephlegmator uncondensed, while the heavier is used for preheating the incoming oil by direct contact and is then returned to the still for further cracking.

The pressure distillate passes to the treating plant for chemical treatment and subsequently to the topping plant for fractionation into gasoline and gas oil. The whole of the oil passing to the reaction chambers is not removed as vapor, as the asphaltic portion of the original oil, together with such heavier fractions as are produced by cracking, is drawn off and blended to produce fuel oil for ship's bunkers.

The gasoline, after chemical treatment, is stored in 80,000-bbl. tanks. It is shipped to England for sale. Present plans are to increase the capacity of the refinery and new cracking units were being erected at the time material for this article was obtained.

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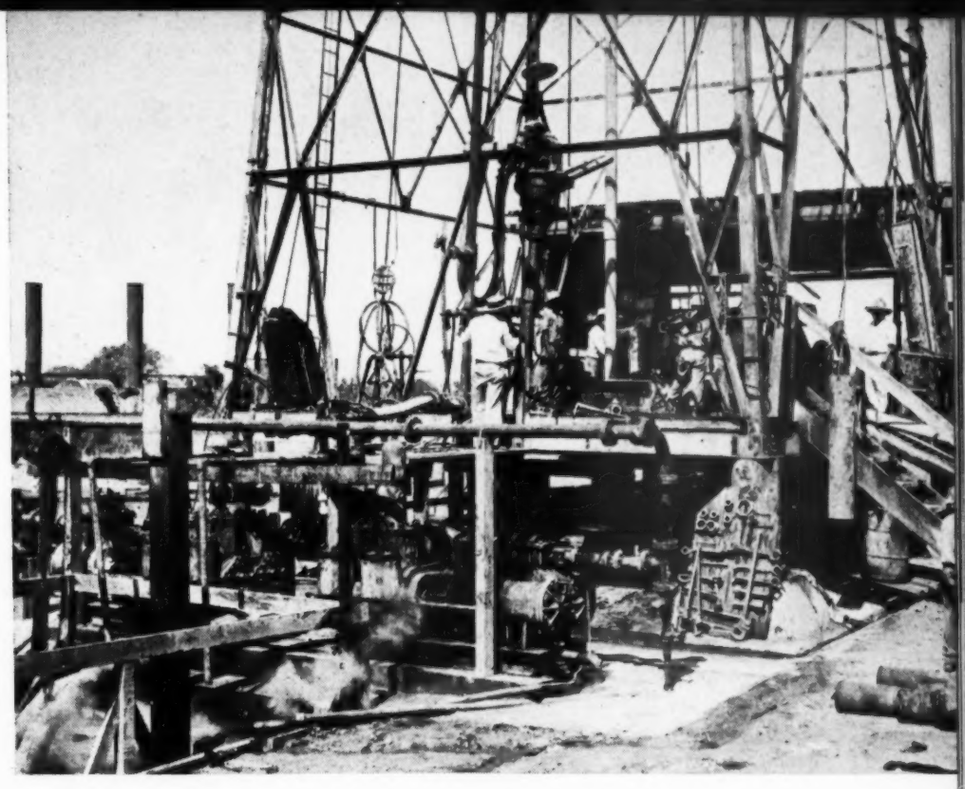


A drilling well in the Ancon field where the rotary method is now being used with Ecuadorian crews

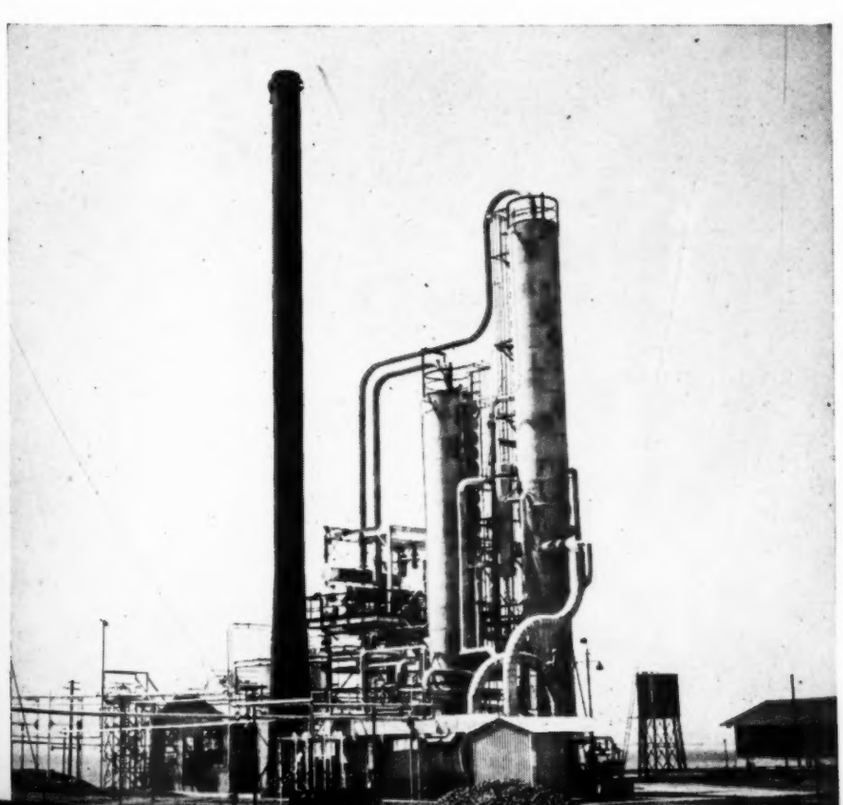
An Unusual Formation and Water Scarcity Present Problems in Ecuador

Many interesting conditions encountered in the Ancon field, where virtually all the oil is produced

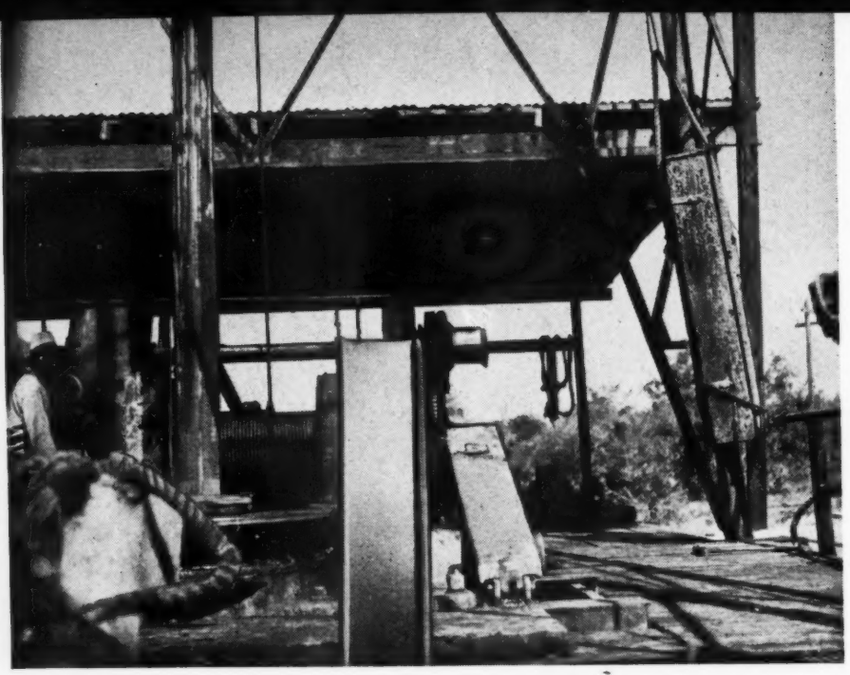
THE entire present oil production of Ecuador comes from a peninsula on the Pacific Ocean lying directly east of Guayaquil, as shown by the map in Fig. 1. Moreover, practically all the oil is produced by one field, Ancon, which is operated by an English company, the Anglo-Ecuadorian Oilfields, Ltd. At the present time the production from this field is approximately 6000 bbl. daily, showing a steady increase since the first report of production made in 1917 when only 17,000 bbl. a year were produced. Many interesting conditions are encountered in the Ancon field, however, and the problems arising, especially those caused by the character of the producing formations and the scarcity of fresh water, make the development of this field somewhat difficult.

In addition to the Ancon field, which lies southeast of La Libertad and south of Santa Elena, there is a small area known as the Cantivo field lying just east of La Libertad, and another one at Carolina west of La Libertad. The former is operated by the British Controlled Oilfields, Ltd., and the latter by a national company. In both there has been some shallow drilling but most of the production has come from hand-dug pits. From these pits a quantity of earth impregnated with oil has been mined and roads have been built with this product.

In the Ancon field, the early development was entirely with cable tools. At present, however, rotary tools are being employed and all the deeper-zone wells are being drilled by that method. Some of the older wells drilled with cable tools have been, and are being, deepened and a portable cable



This new type of distillation unit at La Libertad is completely automatic in control



The derrick floor on the right rear of which are the drag and rock bits used for drilling wells in the Ancon field

tool machine is used for the purpose.

The geological features of the Ancon area are of considerable interest and of great importance. Production comes from a shallow zone and from a deeper zone. The shallow zone consists of a large number of sands that produce a low cold test oil of naphthalene base that has an export gravity averaging 37 deg. A.P.I. The lower zone is a thick sand that produces a high cold test oil of paraffin base that has an export gravity of 41 deg. A.P.I. Wells completed in the upper sands always are pumpers and average about 25 bbl. a day. The deeper sand wells usually flow naturally and large producing wells often are mixed in with small ones.

Between the shallow sand series and the deeper sand is a clay-pebble bed that ranges in thickness from 800 ft. to 1000 feet. Below this is a shale bed in which the water strings generally are set. Under the shale, however, there is sometimes a bed of black

Fig. 1. The entire oil production of Ecuador comes from the Peninsula shown in this drawing

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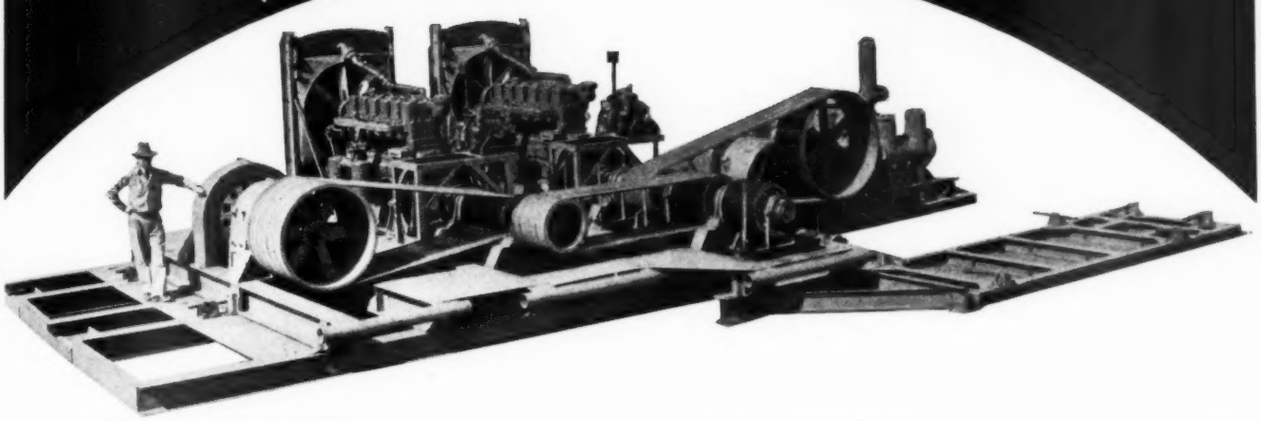

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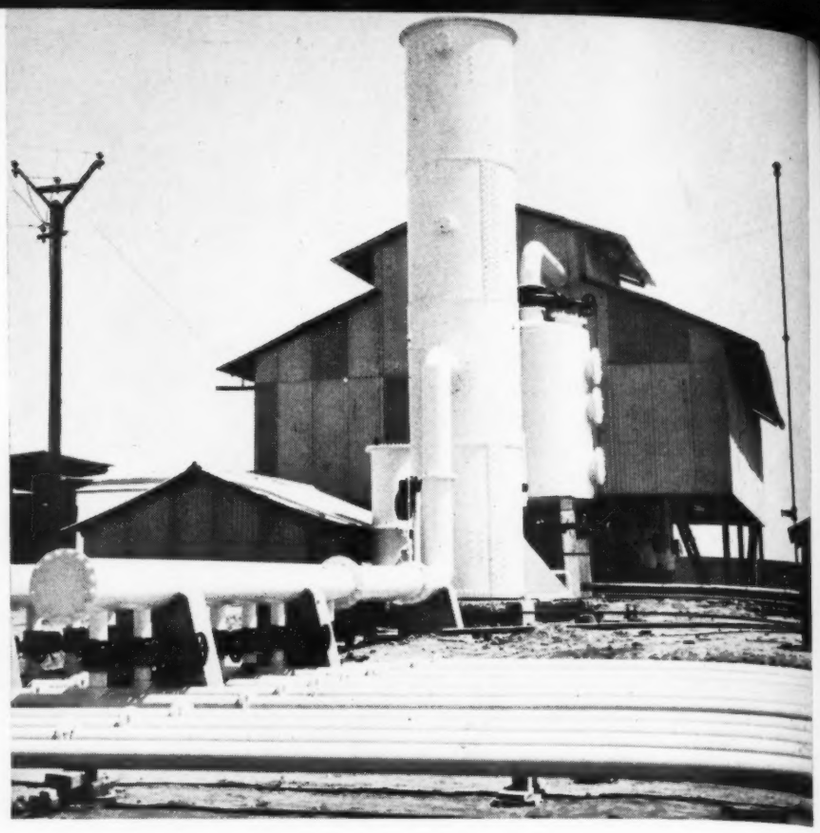


The charcoal absorption plant at Ancon field. The absorbers are housed in the building to the rear

shell. This formation is sometimes missing but may be found up to 1000 ft. in thickness. The formations are indicated in general by Fig. 4.

The deeper producing horizon is known to be more than 2000 ft. thick, as it actually has been drilled through. This sandstone is a rather remarkable formation, as all signs of stratification are lost and the formation appears to have flowed more or less like pleistocene would under pressure. The sandstone gives evidence of being nonporous and the oil seems to be entrapped in innumerable fissures that occur throughout the formation. The deeper producing horizon, therefore, can be considered an unsaturated sandstone.

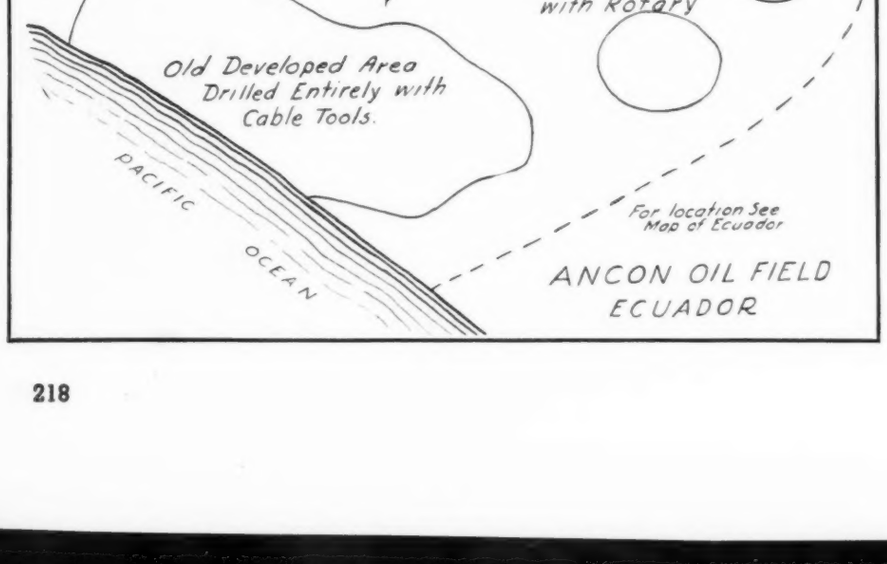
There is, moreover, no uniformity in the oil-bearing possibilities of the sand throughout the productive area. Large wells may be brought in with small wells offsetting them; yet the rate of decline is very low although the occurrence of oil is periodic.

Due to the difficulties in geology, the seismograph is being called in to assist in making locations. In Fig. 2 is shown the older area drilled entirely with cable tools and the newer areas now being developed. The broken line is an arbitrary outline of the area that might be considered proved at the present time. Locations within this area may be made by geophysics as well as geology, and further development outside the area indicated may follow at a later date. The development has moved from west to east and is still progressing eastward.

Fig. 2. This drawing shows the older area of the Ancon field, as well as the areas now being developed

Another problem in Ecuadorian operations is the lack of fresh water. The Ancon field and the refinery at La Libertad are on opposite sides of the peninsula, as shown in Fig. 1. Vegetation here is sparse, although the country around Guayaquil (which is less than 90 miles to the east) is practically a jungle. The coast at this point, however, is barren, as mountainous country to the northeast diverts the waters from the Andes into rivers whose junctions are near Guayaquil. Being on the ocean, however, the climate at Ancon is kept pleasant by the Humboldt Current that flows up from the Antarctic region.

Water, however, is taken from the sea for all operations at both Ancon and La Libertad. For drinking, washing, and other purposes where fresh water is obligatory, the supply is provided by means of distillation. The water is pumped from the ocean into storage tanks; from these tanks it goes to a battery of Galloway boilers where



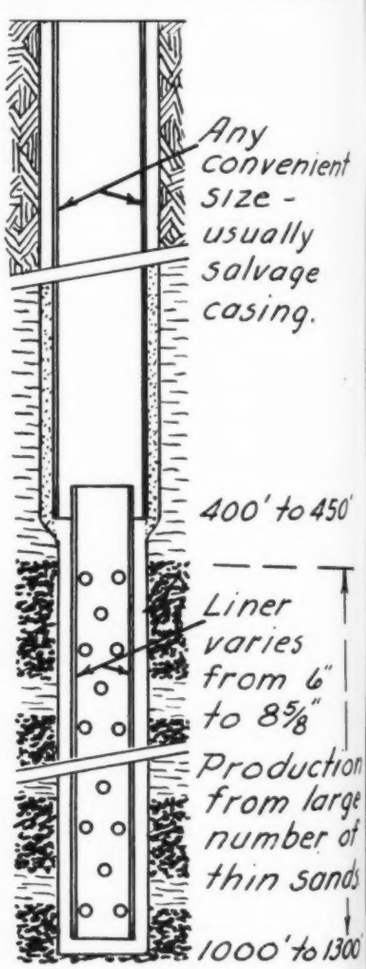
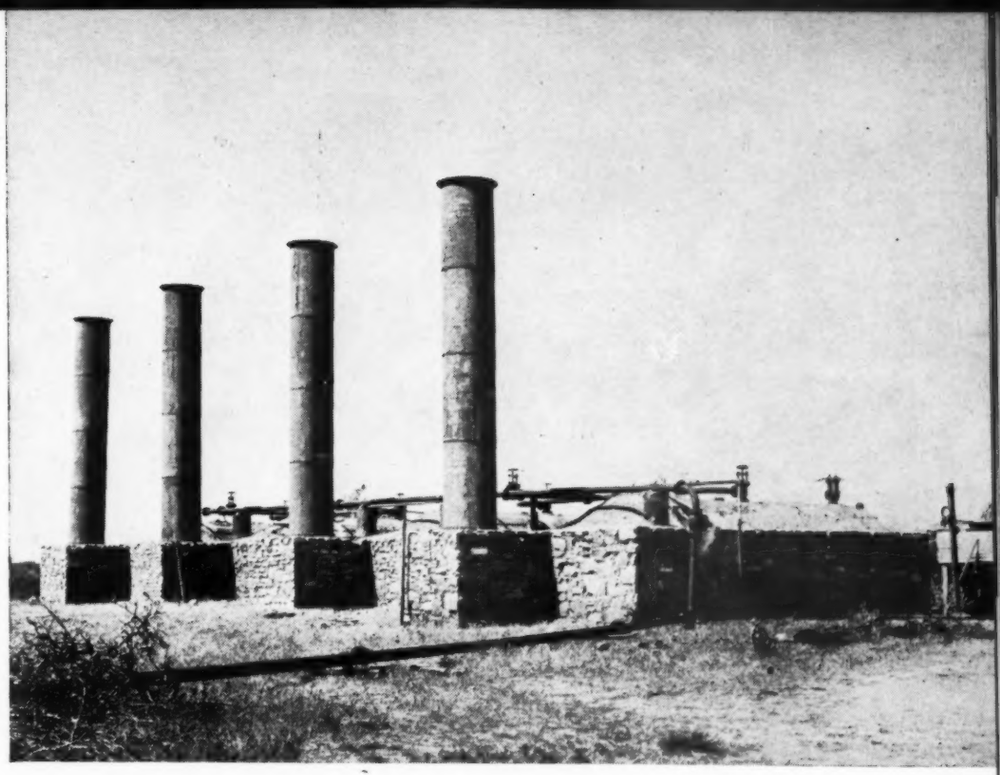

Any convenient size - usually salvage casing.
400' to 450'
Liner varies from 6" to 8⅝"
Production from large number of thin sands
1000' to 1300'

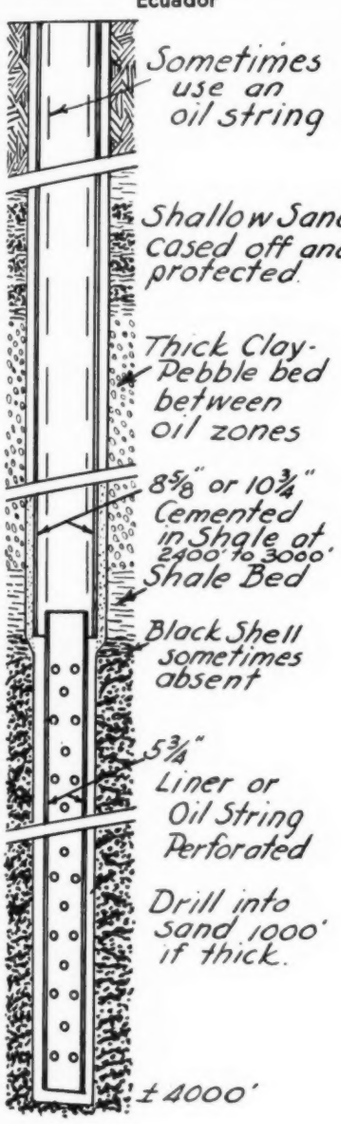
Fig. 3. Well completion in shallow sands, Ancon field, Ecuador



Boilers for rotary drilling at Ancon. Sea water is used and this type boiler with its masonry construction is utilized for the purpose. Two side flues and a bottom flue are built with rock

it is converted into steam. The steam is then condensed by passing it through coils. At present the distillation unit at Ancon utilizes air-cooled coils while the one at La Libertad is built with coils running into the bay for water-cooling. These units have been adequate for the necessary supply of fresh water but soon are to be modernized and enlarged to provide a greater volume. Water for steam generation, drilling fluid, cooling, and similar operations will continue to be taken from the ocean.

Fig. 4. Rotary well completion in deep production horizon, Ancon field, Ecuador


Sometimes use an oil string
Shallow Sands cased off and protected
Thick Clay-Pebble bed between oil zones
8⅝" or 10¾" Cemented in Shale of 2400' to 3000'
Shale Bed
Black Shell sometimes absent
5¾" Liner or Oil String Perforated
Drill into Sand 1000' if thick.
± 4000'

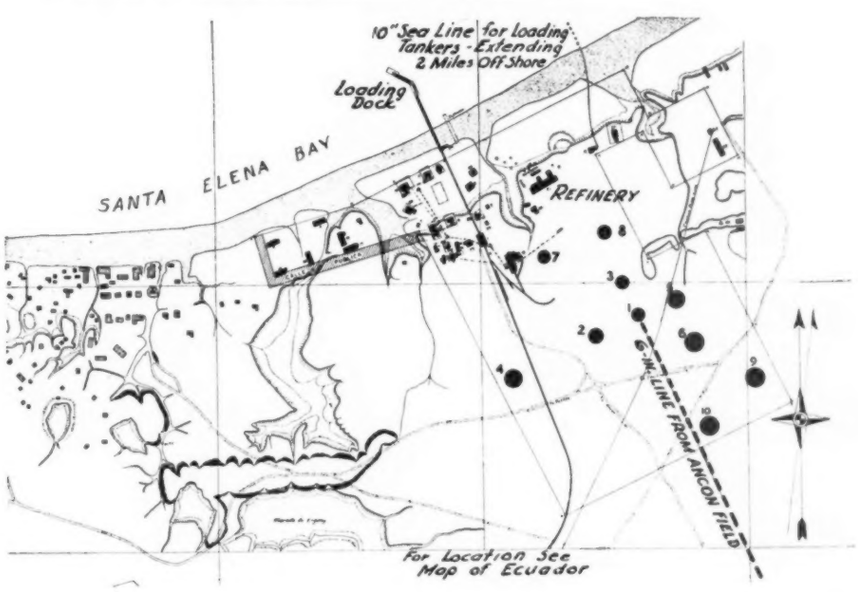
Drilling Methods

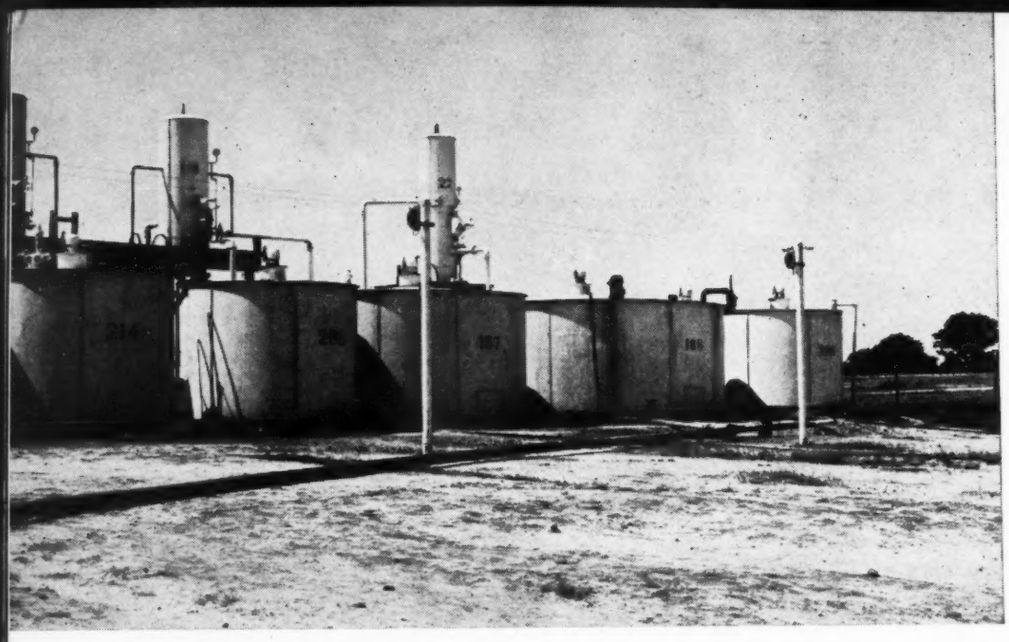
Drilling in the Ancon field is with Ecuadorian crews under supervision of an English superintendent and English tool pushers. Three rigs are running on deep locations and one on shallow locations. There are 450 wells producing but the majority are pumping from the shallow sand at the present time. With drilling to the deeper zone increasing, however, the number of deep-sand wells probably will exceed the shallow wells in the near future.

The method of drilling the shallow wells is indicated in Fig. 3. The surface string, set at from 400 to 450 ft. is cemented and also serves as a water string. Salvaged casing of any convenient size available is used for this string. After drilling to bottom, a perforated liner is set of a size from 6-in. to 8⅝-in., according to the diameter of water string used. In some wells a combination string has been used, with open hole carried from the surface to the bottom. Inasmuch as these wells are completed at from 1000 to 1300 ft. it is felt that it may be possible to drill the entire depth with one bit when a combination string is to be used.

There is practically no gas produced in the shallow wells, which are put on the pump as soon as completed. They are merely bailed out to bring them in and most of them are pumped with central powers. As mentioned, the average production from the shallow wells is approximately 25 bbl. a day but their decline is normal throughout the area.

Fig. 5. The Anglo-Ecuadorian Oilfields, Ltd.'s refinery, tank farm, and loading facilities at La Libertad, Ecuador

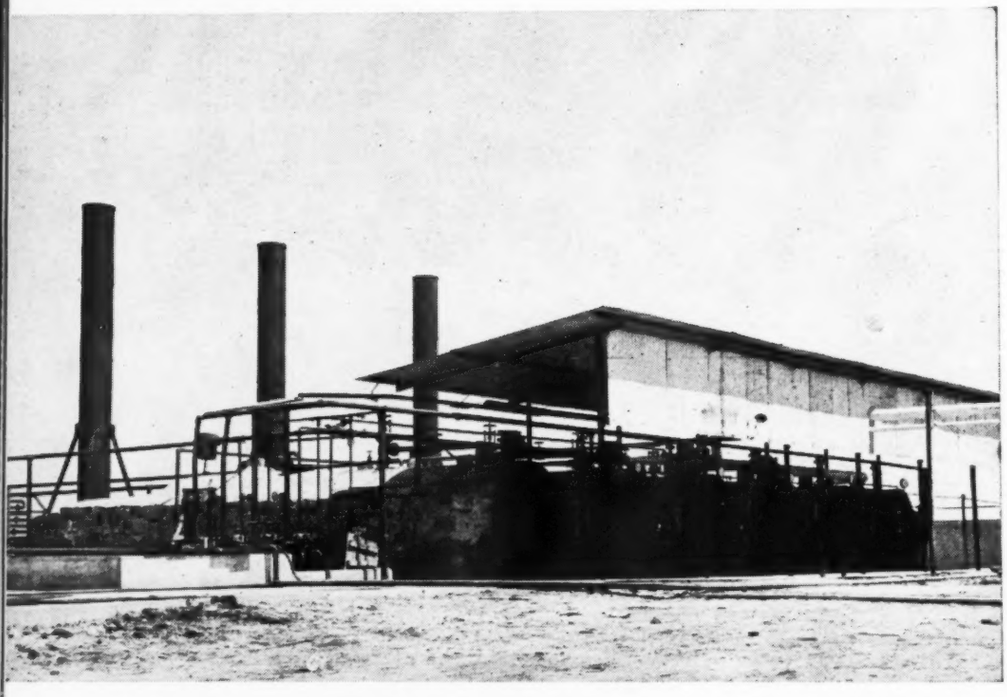

10" Sea Line for loading Tankers - Extending 2 Miles Off Shore
Loading Dock
SANTA ELENA BAY
REFINERY
6-IN. LINE FROM ANCON FIELD
For Location See Map of Ecuador



Tanks and separators handling production from deep sand wells, Ancon field

The average depth of the deep sand wells has been approximately 4000 ft. with the deepest production to date coming from a little below 5000 feet. The casing program is shown in Fig. 4, together with an indication of the formations penetrated. The water string is cemented easily in the shale bed, which varies in thickness in different parts of the field but is always found below the clay-pebble stratum. Although the more usual practice is to use a 5⅜-in. liner, oil strings of the same size also have been run in some of the wells.

The deepest well now being planned will go to 8000 or 9000 feet. The casing for this will be floated in as will casing in all deep tests. The lower producing zone has a thickness that reaches to as much as 2000 ft. and wells are drilled for 1000 ft. into the sand if the sand thickness warrants.



This battery of boilers generates steam from sea water for use at the charcoal absorption plant

Drag bits, usually of the 4-way type, are used except in hard formations, and here 3-cone rock bits are employed. The holes are kept vertical by means of surveys made with acid bottle at 500-ft. intervals. Electrical logging is not used because of the non-porosity of the sand.

Mud fluid is made from native clays and has good colloidal properties. Pressures encountered are not high and seldom exceed 1100 lb. per sq. inch. The mud, therefore, does not have to be heavy and is usually kept at 10.5 lb. per gal. (approximately 78 lb. per cu. foot.)

The surface equipment used is shown in accompanying illustrations, and the derricks on all present rotary operations are of steel and 120 ft. in height. Of particular interest is the substructure and cellar construction. The structural steel floor base is supported on lengths of steel pipe set on concrete piers. The foundation for the en-

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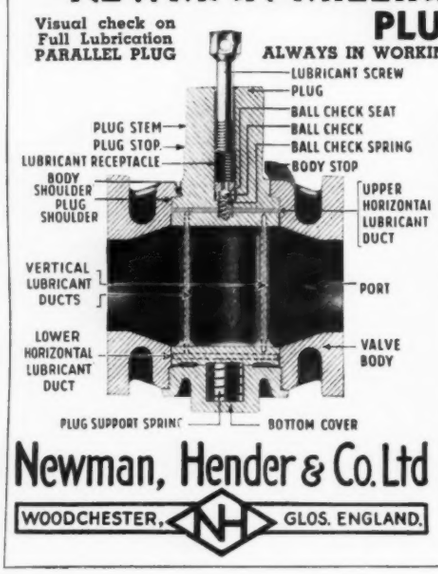

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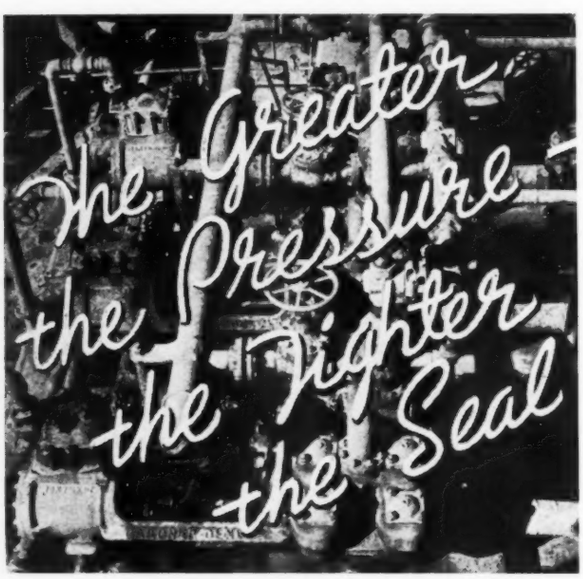

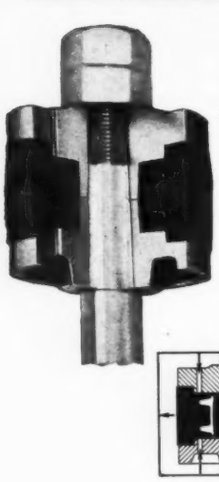

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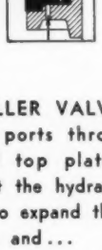

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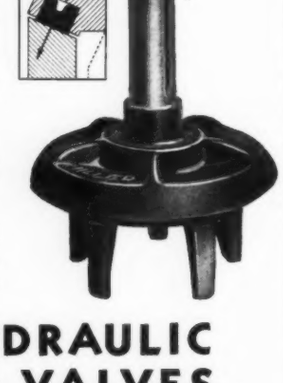

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gine and drawworks is a structural-steel unit resting on concrete foundations. The cellar thus is formed by building the derrick floor above ground, as shown in the accompanying illustrations, with the mud pumps mounted on skids and set on ground level below the derrick floor. Flexibility to meet variations in the surface of the ground readily is provided by cutting the pipe supporting the steel base to the length required at any point.

Since salt sea water is used for steam generation, Cornish boilers of the type illustrated are necessary. The installation of these boilers requires masonry as shown and native rock is used for this purpose. Each boiler is provided with a flue on each side and one below. Boilers are blown down every hour and have to be scraped and cleaned every 15 to 17 days. All condensate that can be recovered efficiently is utilized and as much dilution of the salt water with fresh water as possible is made in the boilers. In shallow drilling one boiler installation is made to take care of several wells.

Production and Gas

In completing the lower sand wells, they are bailed until a showing of oil is had. A string of 2-in. tubing is then run in and when it is in position the well is closed in, built up with pressure, and made to flow. With but few exceptions the deep-sand wells flow naturally. All are beaned with back pressures held at from 60 to 200 lb. per sq. inch. The tubing-head pressure ranges up to 300 pounds.

In producing the wells in the Ancon field the aim is to procure a high ultimate yield. The gas/oil ratio of new wells averages only from 400 to 500 cu. ft., although some of the deep wells have a gas/oil ratio up to 800 cu. feet. Gas is taken from the separators and goes to a charcoal plant or to compressor stations. It enters the charcoal plant at a pressure of 20 lb. and is taken into the compressors at 7-in. water vacuum. At some compressor stations the wet gas is treated at home-made absorbers like the one shown in an accompanying illustration.

Some of the shallow wells have been repressured but plans now have been completed for high-pressure repressuring of deep-sand wells. Equipment for this purpose has been ordered and is now on the way. In this repressuring operation bottom-hole pressure bombs will be used and the project conducted in accordance with the most modern technique.

At present some shallow sand wells are being repressured by gas from the casing head of the deep well. This gas is taken off at a pressure of 500 lb. and put in at 80 pounds. There is, of course, not much gas to spare because the gas/oil ratio of the wells is so low.

Clean-out work is done with a mast mounted on a truck. Wells as deep as 3000 ft. have been pulled with this equipment. Deepening of old cable tool wells, as mentioned, is being done with the portable machine, as shown in an accompanying illustration. This machine also is used for salvaging casing.

Electric power is used for lighting, for refining operations at La Libertad, and a few other purposes. It is generated at a plant at Ancon by five 100-kw. a-c. sets. A new 180-kw. set is soon to be installed.

As in all South American operations, everything has to be done in the field and, in addition to the large inventory of equipment necessary, facilities for all types of repair work are available. The shops are called upon for many kinds of construction operations to meet the emergencies that arise. A government owned and operated railroad connects La Libertad and Santa Elena with Guayaquil but equipment and supplies are received mostly at the port at La Libertad. A 60-cm. gauge railroad, operated by the company, connects Ancon with La Libertad where is situated the ice plant and oxygen plant. Gasoline and Diesel locomotives of 40 hp. are used on this road.

Refinery and Port at La Libertad

The crude oil from the Ancon field is pumped through a 6-in. pipe line, about 12 miles in length, to a tank farm at La Libertad. (See Fig. 5.) Approximately 1000 bbl. daily of this crude is used by the refinery and the rest shipped to points all over the world. Tankers are loaded with crude oil through a 10-in. sea line that extends for two miles off shore. Bulk shipments of refined products are loaded on board ship through four 4-in. lines on the pier.

The refined products manufactured consist of gasoline, kerosene, heavy naphtha, gas oils, and fuel oil. These are distributed over Ecuador and bulk stations are situated throughout the country. Bulk shipments are loaded into ships through the four pier lines, but in addition to the bulk shipments there is a considerable volume of refined products shipped in cans.

The recently-installed refining equipment shown in the accompanying photographs utilizes an oil-circulating system in which the quantity of circulating oil is many times that of the crude. This mass of oil is used as a heat vehicle for the elevation of the topped crude from the gasoline fractionating tower to vaporizing equilibrium temperatures. The design aims to give maximum thermal efficiency with a minimum personnel. Operations are at atmospheric pressure and are automatically controlled throughout.

The equipment includes an inside-fired oil circulation heater with the radiant heat transfer surface consisting of a circular corrugated firing tube. Oil is directed on this surface by nozzles that cover it entirely with jets of oil at a velocity of 90-100 ft./sec. and, discharging against the fired sheet, provide an unbroken, rapidly moving, and continuous flow of oil over the heated surface. The nozzles are arranged in a "nozzle-sheet" that is a concentric steel tube and by their spacing pass a sufficient volume of oil over the heated sheet at all times to absorb the heat from high temperature combustion and still avoid high film temperature. The transfer rates resulting are high.

The oil uniformly discharged by the nozzles flows between the nozzle sheet and firing tube from back to front of the heater, increasing in velocity as it picks up the flow from all nozzles as it progresses. The front end is the fired end and the volume of oil is at its maximum here where the greatest amount of heat is to be absorbed. An annular header is around the heater at the front end that collects the heated oil that then flows under circulating pump pressure to the vaporizer. The heater always is under low pressure, operates full of liquid, and causes no vaporization.

A single-stage vertical centrifugal pump takes suction from the vaporizing tower and supplies the heater with circulating oil, which is discharged into a circular header placed around the center of the heater. The oil is uniformly distributed to nozzles in an annular space between the nozzle sheet and an outer concentric tube or shell of the heater.

The unit is charged with automatic control by a centrifugal pump. After going through a settler, the oil passes through a tubular conversion section of the heater where it is partially vaporized and through which it flows with high velocity. The mixed oil and vapor, still under the pressure of the crude charging pump, goes to the gasoline refractionating tower from the top of which gasoline is taken off in the vapor phase.

After being stripped, the hot, partially-topped crude flows to the injection line of the vaporizing tower where it joins the circulating oil. As stated, the quantity of circulating oil is many times that of the crude and this great volume of oil is used as a heat vehicle for the elevation to vaporizing equilibrium temperatures of the topped crude from the gasoline fractionating tower.

The circulation oil, with the partially topped crude (after elevation to vaporizing temperature and containing the vapor

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flashed at this temperature), is mixed in the injection line of the vaporizing tower and introduced into the vaporizing head in the top of the tower. The cleanly-separated vapors are then injected under rectifying plates and over stripping plates for the next stage of fractionating.

The circulating oil and the part of the crude not vaporized flow to the base of the vaporizer, which serves as a reservoir for the oil heating system. From here it is discharged to the heater by a single-stage centrifugal pump. A second pump of the same design, and also using the base of the vaporizer as its reservoir, supplies heating oil to the various reboilers of the unit and discharges the excess unstripped residuum to the next fractionation stage in the tower. Oil used as a heating medium for the reboilers is returned to the vaporizer where it joins the circulating oil and is raised to the temperature of the main oil body by oil-to-oil contact.

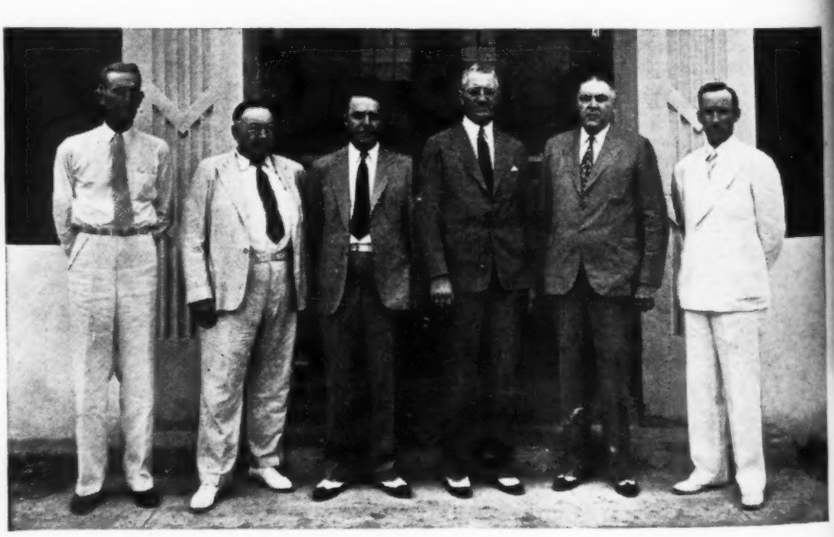
The material used as a heating medium through the heater is unstripped residuum. The crude charge does not enter the heater except when the unit is put on or taken off the line. The quantity of circulating oil through the heater is constant and the partially-topped crude is introduced into the heated stream en route to the vaporizer. The operation of the system therefore is independent of the crude charging rate and any condition of distillation, reference charging rates, or degree of fractionation.

The tank farm, shown in Fig. 5, has a storage capacity of 6500 tons. The tanks have been painted white but the coating, due to atmospheric conditions, does not stand up. Considerable success has been obtained by applying sand on a red lead coating and then whitewashing over that. The plans are to use aluminum paint hereafter, however.

Frick-Reid Enlarges Houston Facilities; Hold Open House

FRICK-REID Supply Corporation recently completed the enlargement of its warehouse and office facilities in Houston, Texas, and in celebration held open house. The affair was well attended by oil men and supply men of Houston and the surrounding territory.

On this page is shown the company's new plant. The other photograph is of several Frick-Reid officials, as well as representatives of the Beaumont Iron Works. They are, left to right: "Doc" Harris, Houston and Beaumont representative of the Beaumont Iron Works; O. C. Staples, Frick-Reid machinery salesman, Tulsa, Oklahoma; J. L. Shakely, vice-president, Frick-Reid Supply Corporation, Tulsa; A. L. Brainard, president, Beaumont Iron Works, Beaumont, Texas; Robert McCoy, Jr., sales manager, Frick-Reid Supply Corporation, Tulsa; and H. C. White, district manager, Frick-Reid Supply Corporation, Shreveport, Louisiana.



YOUR FUTURE CASING PROFITS

THE wise operator keeps in mind the "long pull" for profits. He knows that short-cuts and chances can easily wreck the most promising outlook. He works accordingly, gives careful, thoughtful consideration to each step, scrutinizes every material used, large and small, weighing values, pondering ultimate life and economy.

Casing, the biggest single material expense of the well, comes in for extra close attention. Emergencies sometimes arise in running and cementing — leaky joints may develop — lack of uniformity in casing ends may cause loss of time and labor in make-up. These and other features will largely determine the ultimate profits from the well.

Take no chances — play safe, specify NATIONAL Seamless. Pierced from solid steel, uniform wall-strength is assured. It cannot split at any place along a weld a mile or more down; it has no welds. Carefully finished ends mean that it stabs easily, screws together smoothly and accurately. In your next well, buy your future casing profits now, be sure to specify NATIONAL Seamless A. P. I., Diamond B X and B 8,

America's Preferred Casing, made by the world's largest manufacturer of steel pipe and tubes.

NATIONAL
Seamless Casing
X A.P.I. 8

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Facts Regarding Percentage Depletion

Part II[1]

Taxpayers who have performed and will perform special valuable services for the nation are entitled to percentage depletion deductions

1. Every discovery of unknown natural resources adds to the wealth of the Nation. As soon as the discovery is made, the ad valorem taxes of the states are either increased, or the ratio of assessed value to actual value decreased. Upon exploitation, the federal government takes a large share of the profit as income taxes. If the discovery is upon the public domain, the federal government may take a substantial royalty. If the discovery is made by a corporation, the government will gather a higher capital stock tax, excess profits tax, and probably undistributed profit tax. Not only are the taxes increased by the additional profits from the exploitation of the new deposit, but higher taxes are gathered from the channels into which those new resources may be dedicated.

2. Every discovery adding new natural resources to those previously known to exist adds further security to the public debt, and has a tendency to maintain or diminish interest rates upon the public debt. Every new discovery augments the foundation for our credit structure and aids in preserving it in a state of stable equilibrium. Every new discovery tends to relieve the load on the citizens who will be required to make payment on the redemption of the public debt.

3. Every exploratory program, whether fruitful or unfruitful, creates new jobs and stimulates trade and production of supplies, machinery, and equipment. These explorations themselves are work relief projects toward which the government makes no contributions and grants no reimbursement if the explorations are unsuccessful.

4. Every discovery creates employment that would not exist otherwise. Whenever the discovered deposit is exploited, operating jobs are created.

5. Every discovery creates a new source for trade in the supplies, machinery, and equipment required to exploit the discovered deposit. The stimulation of this trade stimulates the production of these supplies and materials and the increase in this business creates new sources of employment.

6. Every discovery contributes resources that are indispensable in our program for our national defense—for preparedness in time of peace and for operations in time of war.

7. Discovery tends to diminish the prices of mineral and petroleum products and as a consequence enhance the consumer's purchasing power, increase taxable profits in manufacturing and trade, relieve unemployment, and create additional sources of federal and state revenue.

8. The maintenance of adequate petroleum resources is indispensable to the maintenance of present standards of living in our Nation. Hence it is true that discovery is a vital factor in the preservation of our Nation and the preservation of our civilization.

These are some of the benefits that flow to the government as a consequence of the exploratory work of the oil industry. It is for these benefits that the government may well afford to grant adequate depletion allowance deductions from income of a taxpayer when it can be shown that the source of that identical income would not have been known to exist if it were not for the *explorations* of that taxpayer.

A prerequisite to the discovery of these unknown deposits is an expensive wildcat exploration program in which the capital employed is subjected to great risks of loss.

These discoveries are not made without sacrifices. Prospecting, whether for oil, gas, or minerals, is an expensive undertaking. It is generally coupled with many disappointments, and the degree of success depends in most cases upon elements of luck over which the taxpayer has no control. Dry holes and faulty structures are common, notwithstanding the fact that the best geological practice is applied. Prospecting is an inexact science, and the volume of oil discovered is not directly proportional to the funds appropriated to these purposes.

The percentage depletion allowance is a meritorious one that is an inducement to explore and a reward for the discovery of new national wealth and income, new sources of employment and trade, new resources for national defense, new means of improving standards of living, and new weapons to combat poverty and spur business recovery.

Any additional revenue derived from revocation of the rights to measure depletion by a percentage of income will be more than offset by the public detriment resulting from such revocation

1. *The benefits that the public may derive from the additional revenue must be diminished by the detriment resulting from the reduction of income, purchasing power, security, and standards of living of those who bear the additional tax burden.*

The imposition of any additional taxes, especially at a time when existing taxes are relatively heavy, involves substantial public detriment from the reduction of the income, purchasing power, security, and standards of living of the people who bear the burden of the tax. If the income of a great host of the American people is to be curtailed because they must bear the additional tax burden, then to the extent that this group is a part of the American public there is public detriment. For example, if 130,000,000 people in United States may benefit from the additional revenue and the burden of paying the tax falls on one hundred million of the one hundred and thirty million, it is necessary, in considering the propriety of the tax, to consider the public detriment that results from placing this additional burden on the 100,000,000 payers.

Who will bear the burden of any additional taxes that may be imposed upon the petroleum industry? Part will be passed on to the purchasers of petroleum and the balance will be absorbed by the owners.

Who are the consumers of these products who will share part of the additional burden that would result from revocation of the right to percentage depletion?

First, there is that class of ultimate consumers of these products who use the products to satisfy their individual needs. This group embraces, among others, the people who heat their homes with coal or fuel oil; the people who purchase or operate automobiles; the people who purchase any of these products in the construction, repair or operations of their homes, tools, implements, etc. Manifestly this group embraces directly or indirectly every individual in the Nation.

Secondly, there are the manufac-

[1]For Part I of this series see "Course of Oil," July issue.

MODERNIZE YOUR ROTARY RIGS

DI-HARD
DI-HARD
DI-HARD

turers who use petroleum as a component part of manufactured goods or consume petroleum products in manufacturing processes. Obviously there are few, if any, manufacturers who do not fall in this category. The owners of the great group consist of millions of our citizens.

In the third place there is the United States and the several states. The United States is one of the largest consumers of petroleum and its products. Petroleum is a commodity that is indispensable to national defense, public works, and governmental operations.

Who are the owners of the petroleum industry?

These owners are composed of individual operators, corporate shareholders, lessors of mineral rights, and, indirectly, the employees.

Thus if additional taxes are imposed on the industry, practically every individual in the United States who contributes to the payment of these taxes tends to increase their cost of living, to reduce their purchasing power, impair their security and decrease their standard of living. These are public detriments that cannot be disregarded in testing the propriety of imposing additional taxes resulting from changing the percentage allowance.

The millions of employees in the petroleum industry have an interest in the question of the propriety of the taxes imposed upon their employers. The gross income of any industry is divided between government, capital, and labor. If this gross income remains constant and governments demand a greater share, then there is an equivalent reduction of the amount to be distributed between capital and labor. The greater the government's share, the less the power of capital to grant labor benefits. If government takes it all there is nothing left for capital or labor. The government can kill the petroleum goose on too heavy a tax diet and there will be no more golden eggs for government, capital, or labor. Thus employed men may be converted into unemployed men and prosperity converted into depression. These are additional public detriments that cannot be disregarded in testing the propriety of imposing additional taxes on these industries.

2. *Any additional revenue that might be derived from the revocation of rights to percentage depletion would be set off by incidental losses of revenue.*

   (a) The United States would bear a portion of the additional tax burden as an important consumer of petroleum and its products.

To the extent that any additional tax burden imposed upon the industry might be shifted to consumers in the price of products, the United States would contribute. Thus the United States would assume a portion of the burden of any additional tax that it might impose. As one of the most important purchasers and consumers of these products, the amount of this set off would be substantial.

   (b) Income taxes on manufacturers of petroleum products will be curtailed to the extent that the tax is shifted to them and absorbed by them.

Manufacturers who use petroleum and its products either as raw materials or as consumptive supplies in manufacturing processes will sustain reductions in taxable income to the extent that any tax is passed to them and not passed on by them. To the extent that this taxable net income is reduced the United States will lose income taxes.

   (c) An increase in tax on the petroleum industry will, to the extent that the tax is shifted to consumers, result in increased prices of petroleum products. Increased prices tend to diminish trade in these products with a consequent loss of excise taxes and income taxes to the United States.

These economic principles are too well established to submit to argument. Examples, however, are the cases where gasoline taxes have been so excessive that consumption of gasoline has diminished to an extent that the increase in tax effected a net loss of revenue.

3. *Recision of percentage depletion will deter explorations and diminish the number of discoveries of oil and gas wells. The loss of one important discovery may result in a greater loss to the United States than the amount of additional revenue that may be gathered from recision of percentage depletion.*

What is the value of such discoveries to the United States? Frequent discoveries of unknown oil and gas pools are essential to the maintenance of present standards of living for our citizens and for adequate national defense. These underground resources are the life blood of the nation and the backbone of any prosperity that our citizens may enjoy. They are the source of the means whereby the people satisfy their fundamental wants. They contribute directly or indirectly toward the development of power and transportation. They are indispensable in the arts and sciences. In thousands of ways every person relies upon the utility of these commodities every day. In brief, they are commodities upon which we rely for the maintenance and advancement of civilization.

The practice in the United States of investigating the relevant tax factors before launching any new business enterprise is common, if not universal. In any investigation of the expediency of an exploratory program, the average prudent prospector will estimate the net yield or reward to accrue from success. In determining the net yield from success, percentage depletion is a factor, and thus percentage affects the odds involved in the exploration gamble. If these odds are reduced by recision of percentage depletion, many exploration programs will not be launched that otherwise would be undertaken. Discoveries vary with the amount of explorations. Hence the conclusion is obvious that a revocation of the right to percentage depletion will diminish the number of discoveries. As discoveries are public benefactions, a reduction of discoveries affects a loss to the public. In determining the propriety of rescinding the rights to depletion, this loss cannot be disregarded.

The assertion has been made above that the right to measure depletion by a percentage of income is a factor that must be considered in connection with any proposed exploratory program. The importance of this factor has never been more pronounced than it is today during a period of extremely high income tax rates. In times of high surtax rates investments are more attractive than speculations. An axiomatic principle of investment or speculation is that, other factors being equal, the rewards from an investment or speculation should be commensurate with the risks inherent in the project or enterprise. Generally these rewards are regarded as the profits to be realized *before* taxes, but with the current high rates of tax, any prudent investor must weigh the anticipated reward, *after* taxes, before deciding upon the propriety of an investment or speculation.

As speculation must yield more per dollar of capital than investments, and as the surtaxes are higher on higher yields than on lower yields per dollar of capital, the net yields of speculations cannot be considered as being commensurate with risks unless either (a) the reward anticipated is based upon yield after tax or (b) the degree of risks is measured against yield after tax. To illustrate, taxpayer A has $100,000 to invest. He can bet it on a "manufacturing horse" paying a gross yield of 2 to 1 or a "prospecting

GIVES YOU MORE TIME TO GET IT DOWN

UNAFLO CEMENT—

1. Retains fluidity at highest known oil well temperatures.
2. Permits use of ½ gallon less water per sack of cement.
3. Has set a new record of low pump-down pressures.
4. Follows irregularities of well bore and casing.
5. Attains full strength rapidly under high temperatures.
6. Remains fluid even when contaminated by mud.
7. Remains fluid while being placed, thus forming an impermeable seal against the movement of formation fluids.
8. Has proved in the field that it "sets up" in sulphate waters.
9. Has repeatedly remained fluid for more than two hours on squeeze jobs where pressures and temperatures were extreme.
10. Is a safer cement for oil string and repair jobs.

● When the hole is deep and temperature's high—and trouble starts to pop—that's when you'll appreciate the *extra time* Unaflo gives you! Unaflo sets slower, yet hardens quickly after initial set—forms a tight shut-off against gas and water.

In Oklahoma there is a Johnson Sand well that produces about 1500 barrels of gross fluid per day on gas lift, cutting approximately 98%. It was decided to try to plug off water in this well by attempting to force quantities of thin cement slurry into permeable streaks in the sand, and then remove the cement from the hole.

Thirty-five sacks of Unaflo were pumped into the seven-inch casing between two rubber plugs. Pressures up to 2400 pounds were used. Here's a record of the time:

Mixed 35 sacks	**22 minutes**
Pumping cement in casing	**4 minutes**
Put in follow plug	**7 minutes**
Pumping plug to 6,245 ft.	**5 hrs. 5 min.**
Total Time	**5 hrs. and 38 min.**

Why not give this new and better oil well cement a trial on your next job? Universal Atlas Cement Co., United States Steel Corporation Subsidiary, Amicable Bldg., Waco, Texas. Kansas City, Tulsa, Oklahoma City.

U-11

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FOR SAFE DEEP-WELL CEMENTING

horse" paying a gross yield of 40 to 1. Assuming the most conservative illustration where he has not other income, the net realization if the "manufacturing horse" should win would be $200,000 less $97,000 federal tax or a net of $103,000. The net realization if the "prospecting horse" should win would be $4,000,000 less $3,011,000 federal tax or a net of $989,000. The ratio of the risks assumed on the two horses would be 40 to 2 or 20 to 1, but the ratio of realization would be $989,000 to $103,000 or 9.6 to 1. In states where income taxes are imposed this margin would be greater. Now, if the percentage depletion can be allowed against funds won on the prospecting horse so that the ratio of realization would be somewhat commensurate to the ratio of risks, then more funds will be placed upon the prospecting horse. Thus percentage depletion is in fact not only a reward for special service but an inducement to explore and a stimulus to discovery, and a means whereby this operation of this economic barrier to speculations is lowered. The conclusion is clear—that revocation of these rights would result in less discoveries than if these sections are retained in the law.

If resort is taken solely to monetary tests, actual sound estimates can be made that will prove that the discovery of one important oil and gas structure or one important mine may yield more to the United States than the amount of revenue involved in percentage depletion.

4. *Additional taxes on the petroleum industry prohibit the exploitation of marginal natural deposits and thereby cause losses of national wealth and income.*

Increased taxes represent increases in operating costs. Increases in operating costs affect the amount of natural resources in the United States.

There are unlimited quantities of oil and gas contained in the bowels of the earth. Whether or not this oil will be produced or wasted depends upon the cost of exploiting it, and the cost of exploiting it depends upon the *taxes* that form a component part of these costs. If an increase in taxes increases costs above the recoverable value in the marginal oil deposit, then the oil is wasted. If the increase in taxes is not imposed so that the costs can be maintained at a figure lower than the recoverable values, then the oil may be produced and there is thus created added national wealth, a source of relief for unemployment, and a source of trade for supplies, machinery, and equipment.

Thus, as taxes go up, valuable oil and gas deposits remain undeveloped and the marginal operator is forced out of business. As taxes are reduced, the marginal operation is saved and all profits are increased. The Petroleum Administrative Board has proved that losses of oil and gas reserves available in stripper wells would result from increased labor costs under the proposed code for the petroleum industry. Any increase in tax on the producer through stripper wells will have the same result.

The Dominion of Canada has recognized this principle and in an amendment in 1936 to the War Income Tax Act, all new metalliferous mines are exempted from income taxes.

Bureau of Mines Analyzes Crude Oil From New West Texas Field

THE crude oil produced from Ordovician lime in the Sand Hills field in western Crane County, Texas, is a wax-bearing paraffin-intermediate base oil having a gravity of 44.7 deg. A.P.I. and a sulphur content of 0.22 percent, according to a laboratory analyses made by the Bureau of Mines on Mines, Department of the Interior, on a sample obtained from Gulf Production Corporation, Waddell well No. 4, sec. 4, blk. 27. A distillation summary indicates approximately 35 percent of gasoline and naphtha, 20 percent of kerosene distillate, and 25 percent of gas-oil and heavier distillate suitable for cracking. The analysis of this oil compares favorably with previous analyses made by the Bureau of Mines on oil produced from the heavy-oil zone of the Ordovician strata in the Big Lake field, Reagan County, Texas.

The Sand Hills field is the second field to produce from the Ordovician strata in the West Texas Permian Basin—the first being Big Lake in Reagan County. Oil was discovered in the Ordovician strata in the Continental-Group One Oil Corporation, University well No. 1-B in the Big Lake field, December 1, 1928. This well was completed at a total depth of 8523 ft. and produced 2,800,000 bbl. of oil prior to March, 1933, when it was temporarily shut down. Twenty-five wells drilled to the Ordovician strata in this field had a total production on January 1, 1936, of 23,000,000 barrels.

Gulf Production Corporation, Waddell well No. 4 from which the sample was obtained for analysis was completed at a total depth of 6014 ft. in a dolomite, probably the Ellenburger formation. Although this was the third well to produce from the Ordovician strata in the Sand Hills field, it is the first important well and produces by natural flow. Two wells drilled previously had small initial production and are produced by pumping.

Approximate Summary

	Percent	Sp. gr.	Deg. A.P.I.	Viscosity
Light gasoline	11.0	0.665	81.3	
Total gasoline and naphtha	34.8	.716	66.1	
Kerosene distillate	20.1	.792	47.2	
Gas oil	12.4	.833	38.4	
Nonviscous lubricating distillate	8.4	0.847—0.875	35.6—30.2	50—100
Medium lubricating distillate	3.9	.875— .887	30.2—28.0	100—200
Viscous lubricating distillate	.....	.....	.....	Above 200
Residuum	18.4	0.936	19.7	
Distillation loss	2.0	.....	.....	

The detailed analysis of the crude oil is given below:

GENERAL CHARACTERISTICS

Specific gravity 0.803 — A.P.I. gravity 44.7 deg.
Percent sulphur 0.22 — Color greenish black
Saybolt Universal viscosity at 77 deg. fahr. 40 seconds
Saybolt Universal viscosity at 100 deg. fahr. 37 seconds

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

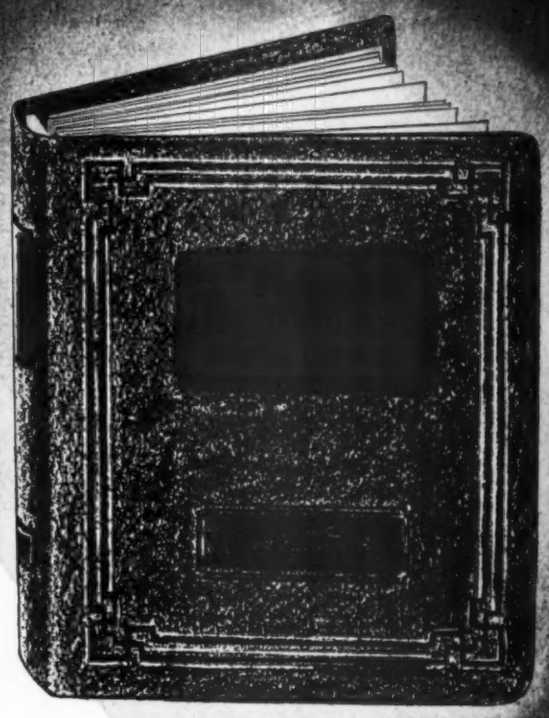
Dry distillation — Barometer 744 mm. — First drop: 33 deg. cent. (91 deg. fahr.)

Temperature deg. cent.	Percent cut	Sum, percent	Sp. gr. of cut	Deg. A.P.I. of cut	Viscosity at 100 deg. fahr.	Cloud test deg. fahr.	Temperature deg. fahr.
Up to 50	2.8	2.8	0.641	89.3			Up to 122
50— 75	4.1	6.9	.656	84.2			122—167
75—100	4.1	11.0	.690	73.6			167—212
100—125	5.9	16.9	.714	66.7			212—257
125—150	6.0	22.9	.733	61.5			257—302
150—175	5.9	28.8	.749	57.4			302—347
175—200	6.0	34.8	.763	54.0			347—392
200—225	6.1	40.9	.777	50.6			392—437
225—250	6.3	47.2	.792	47.2			437—482
250—275	7.7	54.9	.805	44.3			482—527
Vacuum distillation at 40 mm.							
Up to 200	5.1	5.1	0.824	40.2	39	20	Up to 392
200—225	5.9	11.0	.834	38.2	43	35	392—437
225—250	5.2	16.2	.851	34.8	52	45	437—482
250—275	4.4	20.6	.869	31.3	74	60	482—527
275—300	4.1	24.7	.881	29.1	120	75	527—572

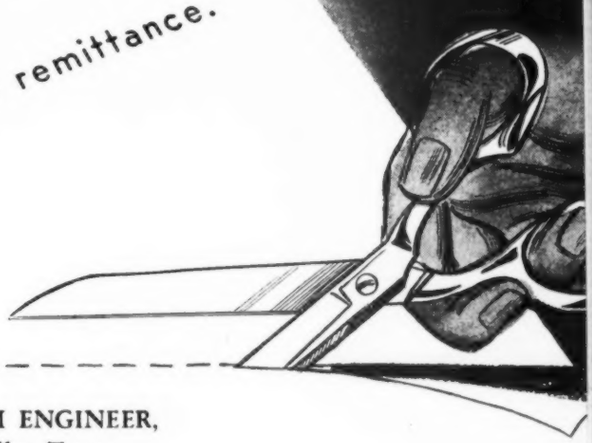
Carbon residue of residuum 6.8 percent — Carbon residue of crude 1.3 percent.

THE *Petroleum* Engineer's

SPECIAL BINDER



FOR SUBSCRIBERS to The Petroleum Engineer who find it convenient to file portions of the magazine for ready reference, we have had manufactured a special three-ring binder. It is a standard size, flexible, durable leatheroid binder with dividers for each division of the industry. The binder may be had for $1.25, express paid, by filling in the attached coupon and mailing it to us with your remittance.



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International Petroleum Exposition to Enlarge Its Exhibit Space

EXHIBIT facilities at the May 14 to 21, 1938, International Petroleum Exposition at Tulsa, Oklahoma, will be increased 40 percent, according to General Manager W. B. Way. Way also announces that September 15 has been set at the deadline for exhibitors at the last Tulsa show to take up the option granted them on their old space. After the deadline all space not reserved will be open to the selection of new exhibitors and old companies who wish to enlarge on their exhibit facilities for the coming show.

E. MERL CLARK

In order to increase exhibit space, the east fence is being moved back 150 ft. and a new plat has been made to show the additional outside space. A new drive is being built on the east side, similar to the Drake Drive on the West side, and a new modernistic cafeteria building is being erected also on this side of the grounds.

New entrance and exit gates are to be erected on the east side to handle the increased activities and the larger crowds expected.

Dr. C. K. Francis, who was the official representative of the Exposition at the recent World Petroleum Congress in Paris, gave a report on the Paris Congress to the executive committee.

The invitation presented to the Congress to hold the next and 1940 World Congress in Tulsa in conjunction with the 1940 International Petroleum Exposition was favorably received, according to Dr. Francis' report.

Plans are being made to name soon the chairmen of the various committees. The assistant manager for the exposition will be E. Merl Clark, who was appointed recently. Clark has been a resident of Oklahoma for the last seven years, and variously has been connected with Barrow-Wade-Guthrie and Company; Arthur Young and Company; and Mattison and Davey.

Executive Committee, International Petroleum Exposition. Front row, left to right: Alf G. Heggem, W. G. Skelly, president, and Frank J. Hinderliter. Top row, left to right: W. M. Bovaird, Frank O. Prior, H. R. Powers, and W. B. Way, general manager. Clyde H. Pape, treasurer, was not present when the picture was taken

Illinois Mineral Industries Conference October 8 and 9

Of interest is an announcement by M. M. Leighton, chief of the Illinois State Geological Survey, regarding the preliminary program of the Fifth Annual Illinois Mineral Industries Conference to be held at Urbana on Friday and Saturday, October 8 and 9, under the joint sponsorship of the Geological Survey, the Engineering Experiment Station of the University of Illinois, and the Illinois Mineral Industries Committee.

Although the complete list of speakers has not been determined, the high quality of the program already is indicated by the fact that Clyde E. Williams, noted director of the Battelle Memorial Institute, of Columbus, Ohio, has consented to give the main address at the opening session on Friday forenoon. He will speak on "Research in The Mineral Industries," adhering to the theme of the conference itself, which will stress recent scientific and industrial developments of special significance to the mineral industries of Illinois.

The oil and gas program given herewith is tentative.

Current Developments in Oil and Gas
Friday, Oct. 8, 2:00 p. m.

Chairman, T. B. Steele, manager, Kewanee Oil and Gas Company, Secretary-Treasurer, Illinois-Indiana Petroleum Association, Robinson.

"State Regulation of Oil and Gas Production for the Prevention of Physical Waste," by William Bell, Bell Brothers, Robinson, President, Illinois-Indiana Petroleum Association. Representative of Governor Henry Horner in the Interstate Compact Commission.

"Changing Legal Concepts Affecting the Oil and Gas Industry." By Walter L. Summers, professor of law, University of Illinois.

"Economic Aspects of the Fuel Oil Industry." By Walter H. Voskuil, mineral economist, Illinois State Geological Survey.

Saturday, Oct. 9, 9:00 a. m.

"Developments in Illinois Since January 1, 1937." By A. H. Bell, geologist and head of the Oil and Gas Division, Illinois State Geological Survey.

"Oil Exploration in the Illinois Basin." By Theron Wasson, chief geologist, Pure Oil Company, Chicago.

"Water Flooding." (Speaker to be announced.)

"Recent Developments in Water Flooding in Illinois Oil Fields." By Frederick Squires, associate petroleum engineer, Illinois State Geological Survey.

ONE IN EVERY 100 TANKERS CARRIES ALL Waste Cargo

WHEN TRANSPORTING OIL CONTAINING 1% WATER

The transportation department of an oil company is vitally concerned with "cut" oil problems. Here is only one of many reasons:

When shipping crude that contains only one per cent water (usually within pipe line specifications), one per cent of the entire capacity of every tanker is wasted. This is equivalent to one in every 100 tankers carrying all waste cargo. The excessive cost of shipping oil of even a very low "cut", therefore, is readily apparent.

Large savings in marine transportation costs are possible through Petreco Electromatic Dehydration of all wet crude as produced. Petreco engineers are at your service to determine such potential savings, without obligation.

PETRECO *Electromatic* DEHYDRATION of All Wet Crude *pays* DIVIDENDS to All Departments Involved

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Branches and Service Men in Principal Oil Fields

PETRECO

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

And then there was the playwright who got himself married and sent out first night performance invitations to all his friends.

* * *

An elderly gentleman, just recently married, thought he would like an heir.

He consulted a doctor who, after examining said: "You may be heir-minded, but you're just not heir-conditioned."

* * *

The young city girl went swimming in the nude in a secluded mill pond. Along came a little boy who started to tie knots in her clothes. She flopped around, found an old washtub, held it up in front of herself and marched toward the little boy, saying' "You little brat, do you know what I'm thinking?"

"Yes," said the little brat, "You think that tub has a bottom in it!"

* * *

Title of this month's ditty: They Call Her Checkers Because She Jumps When You Make a Bad Move.

* * *

The ladies met on a train. "I'm from Boston," haughtily remarked one. "There breeding is everything."

"Well, I'm from New Orleans," said the other. "We like it there, too, but it isn't everything."

* * *

The negro cook was explaining her family affairs to her white mistress:

"Yas'm, I got five chillun; I had two by my fust husban', an' one by dis Jake husban' I got now—an' I had two by mahself."

* * *

"I would advise you, madam," instructed the doctor, "to take frequent baths, get plenty of fresh air and dress in cool clothes."

"What did the doctor say?" inquired the husband an hour later.

"He said I ought to go to Atlantic City and then to the mountains," related the wife. "Also, that I must get some new light gowns at once."

"Do those Englishmen understand American slang?"

"Some of them do. Why do you ask?"

"My daughter is to be married in London to an earl and he has just phoned me to come across."

* * *

A celebrated white preacher had been engaged to address the congregation of a little Negro church and was being introduced by the colored pastor.

"Sistern and Breddern," he began, "It affords me the extremest pleasuh to introduce de speaker of de evenin'. I wants to explain dat while his skin ain't de same color as de others, I assure you his heart is black as yorn."

* * *

Some people are very systematic. They operate on the theory that you can find whatever you want when you don't want it, by looking where it wouldn't be if you did want it.

* * *

He: Give me your number and I'll call you next week."

She: It's in the book.

He: Good! Now, will you let me have your name?

She: That's in the book, too.

* * *

Rusty says his girl drives so recklessly that when the road turns the same way she does, it's just a coincidence.—*Bridgeport Bulletin.*

* * *

Appearances are deceiving—many a girl who puts up a swell front in society is flat busted at home.

* * *

"Are you the man who gave my brother a dog last week?

"I am."

"Well, mother says to come and take them all back."

* * *

Visitor (in editorial rooms): What do you use that blue pencil for?

Editor: Well, to make a long story short, it's to—er—make a long story short.

Rastus: Brothaw president, we needs a cuspidor.

President of the Eight-Ball Club: I appoints Brother Brown as cuspidor.

* * *

Asked to stay for church service after Sunday school was over, a little girl replied:

"But, mother, I don't want to stay for two shows."

* * *

Judging by their newspaper pictures, all great men die young.

* * *

Vacations

Little bank roll 'ere we part
Let me hug you to my heart;
All the year I've clung to you—
I've been faithful, you've been true!
Little bank roll, in a day,
You and I will start away,
To a good vacation spot,
I'll come back, but you will not.

* * *

"Mother," asked the little one on the occasion of a number of guests being present at dinner, "Will the dessert hurt me, or is there enough to go go around?"

* * *

Here lies a pedestrian.
He's cold as ice.
He jumped only once when
He should have jumped twice.

* * *

Doctor: (Inquiring after school boy who swallowed a quarter): How is the boy today?

Parent: No change yet.

* * *

Family Tree

"Oh, yes," said the proud matron to her friend, "I have six sons."

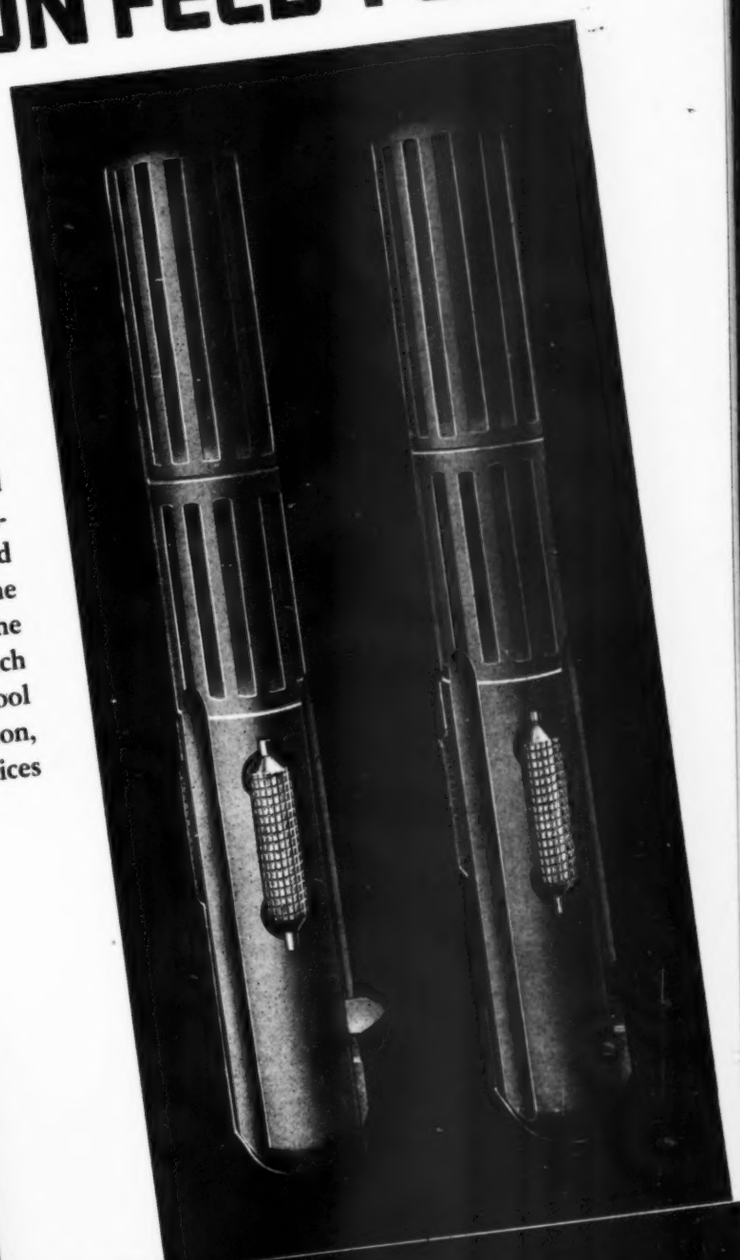
"What are they doing?" asked the friend.

"Well, the eldest is a senator, and the second is also a half-wit. The third has the Croix de Guerre. The fourth wasn't in France either. The fifth is a banker, and his younger brother has the cell next to him. All doing well."

Dependable Inside Cuts With this

ABERCROMBIE
RED BALL
CUTTING SERVICE

FRICTION FEED TOOL



This Cutting Tool, a part of the Abercrombie RED BALL SERVICE in the U. S. and sold in other countries, gives us the same leading position on inside pipe jobs that we have held for more than 15 years on outside cutting. The tool is easy for any crew to operate. Three friction rollers contact the inside of the pipe. Right-hand rotation gradually feeds the blade out by continuous friction of rollers contacting the beveled friction rings which are splined to the shaft. The shaft in turn drives the eccentric bottom of the shaft that is pinned to the cutter blade. A clutch type Releasing Spear run above the cutting tool permits cutting and pulling in a single operation, thus reducing the number of round trips. Prices and delivery dates furnished upon request.

Running Tour
WITH MEN IN THE INDUSTRY

JOHN I. McFARLAND, Calgary, Canada, has been elected president of the McDougall-Segur Exploration Company of Canada, Ltd.

ROBERT BUMAER has been made assistant chief engineer of the Root Petroleum Company, El Dorado, Arkansas. He is a graduate of the engineering school of the University of Tulsa, Tulsa, Oklahoma.

H. D. HUSKEY, Kirkuk, Iraq, who is in charge of drilling operations for the Iraq Petroleum Company, Ltd., is spending his vacation in California and will return to Iraq in September.

E. J. NICKLOS, president of the E. J. Nicklos Drilling Company, Houston, Texas, and his son, Gordon, are in Europe where they will be for the remainder of the summer.

J. W. WINFREY, district petroleum engineer for the Humble Oil and Refining Company, has been transferred from the Amelia district to the Thompsons district.

W. G. CHRISTIAN has been appointed to the Texas Railroad Commission to succeed to the post made vacant recently by the resignation of **E. N. STANLEY,** who was chief conservation law enforcement officer in the East Texas field.

JOHN M. LOVEJOY, president of the Seaboard Oil Company, Amiranian Oil Company, and the Inland Exploration Company, having his headquarters in New York City, is taking his vacation in Europe.

T. E. PATRICK, who has been assistant superintendent at Daisetta, Texas, for the Gulf Production Company, has taken up his duties as superintendent for the Gulf in the Kuweit, Persia, area.

THOMAS BEMIS, Los Angeles, California, has become a member of the staff of the Standard Oil Company of California. He is a petroleum engineer and is stationed at Taft.

JOS. A. KORNFELD has resigned from the staff of the Barnett Petroleum Corporation, Dallas, Texas, to accept the post of oil editor with the Wichita Beacon, Wichita, Kansas.

C. W. McINTOSH, production superintendent in the Bradford, Pennsylvania, field for the Sloan and Zook Company, recently was transferred to the Lisbon field of Claiborne Parish, Louisiana, where he is production superintendent for the company.

J. M. WANAMACHER, of the exploitation engineering department of the Shell Petroleum Corporation, has been transferred from Tulsa, Oklahoma, to become Kansas division exploitation engineer. Shell also announces other changes in the personnel of its Mid-Continent division as follows: **H. E. ZOLLER** from Kansas division exploitation engineer to production superintendent at McPherson; **H. O. RUARK** from production superintendent at McPherson to production superintendent at Tonkawa, Oklahoma; **R. H. GWINNER** from evaluation engineer, Kansas division, to a similar post at Tulsa; **C. H. KEPLINGER** from exploitation engineering department, Tulsa, to evaluation engineer, Kansas division.

P. M. GRIFFITHS, acting manager of the Royal Dutch-Shell at Aruba, South America, has been spending his vacation in England.

CHAS. M. COFFMAN, who has been an engineer in the lube department of the Empire Oil and Refining Company's refinery at Ponca City, Oklahoma, has been transferred to the engineering department at Bartlesville.

A. J. HARDENDORF, of the Fredell Construction Company, Houston, Texas, spent his vacation in Gothmore Park on Casper Mountain, eight miles south of Casper, Wyoming.

F. C. LAURIE, general manager of the Lago Petroleum Corporation in Venezuela is in New York on business and pleasure.

G. W. HEINECKE has accepted a position as chief engineer with the Rodessa Oil and Refining Corporation and will be stationed at Shreveport, Louisiana. Until recently he was vice-president of the Ampco Engineering Company, consulting refinery engineers, Dallas, Texas.

HENRY CARTER REA and **HOWARD M. KIRK** sailed from New York August 6th for Afghanistan where they will spend the next two years doing geological exploration work for the Inland Exploration Company. They may be addressed care of Inland Exploration Co., Kabul, Afghanistan.

D. E. BUCHANAN and **E. I. HANLON,** of Hanlon-Buchanan, Inc., Tulsa, Oklahoma, were granted an interview by Premier Mussolini on their recent visit to Italy. Buchanan was chairman of the official United States delegation and represented the American Petroleum Institute at the Second World Petroleum Congress held in Paris, June 14 to 19. They were also granted an audience by His Sanctity Pius XI.

W. L. BAGBY, who has been superintendent of drilling and production for the Shell Oil Company in the Ventura division, California, has been made manager of the coastal division.

T. G. ROACH, district superintendent at Tomball, Texas, for the Humble Oil and Refining Company, has been transferred to McCamey, Texas. **G. C. NICKLOW,** district superintendent, has been transferred from Gladewater to Tomball, and **J. P. RUCKMAN,** district superintendent, who has been at McCamey, is now at Gladewater.

VERNE TAYLOR, field supervisor of the Turner Valley area in Canada for the Petroleum and Natural Gas Division of the Department of Lands and Mines of Alberta, has resigned and joined the engineering staff of the Royalite Oil Company, Ltd.

That EXTRA Quality

Except that one stand is yellow, "Flex-Set" Performed Yellow Strand Rotary Lines look like any other lines. Then where is that extra quality that makes for extra economical service? The answer is:

It's in the extra quality wire drawn to our own exacting specifications—It's in the extra care used in testing that wire in our laboratory—It's in the selection of those wires which will produce the fine balance of flexibility, elasticity, strength and toughness so necessary to rotary lines.

Finally, it's in the preforming, which sets the wires and strands to the helical form they will occupy permanently in the finished lines. They are thus largely pre-broken in — limp — easy to handle and install — highly resistant to kinking, drum crushing, fatigue.

Try "FlexSet" Performed Yellow Strand Rotary Lines for economy.

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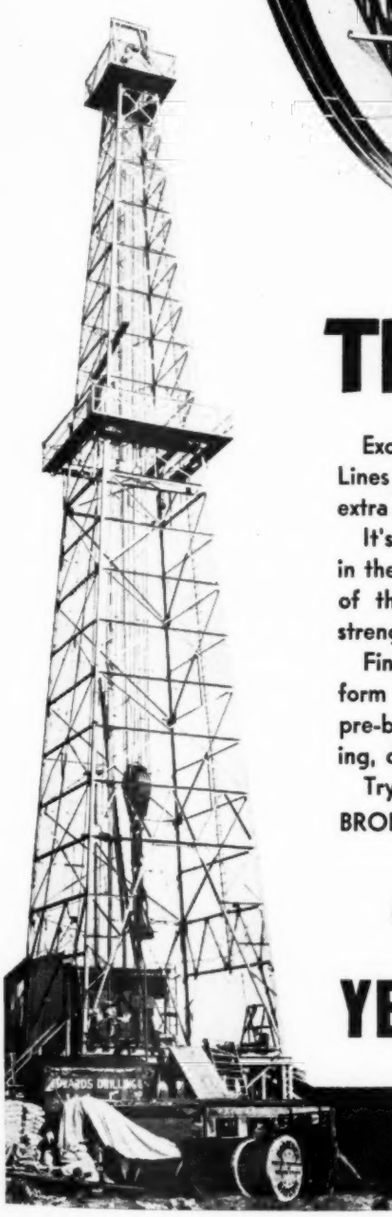


"FLEX-SET" PREFORMED YELLOW STRAND ROTARY LINES

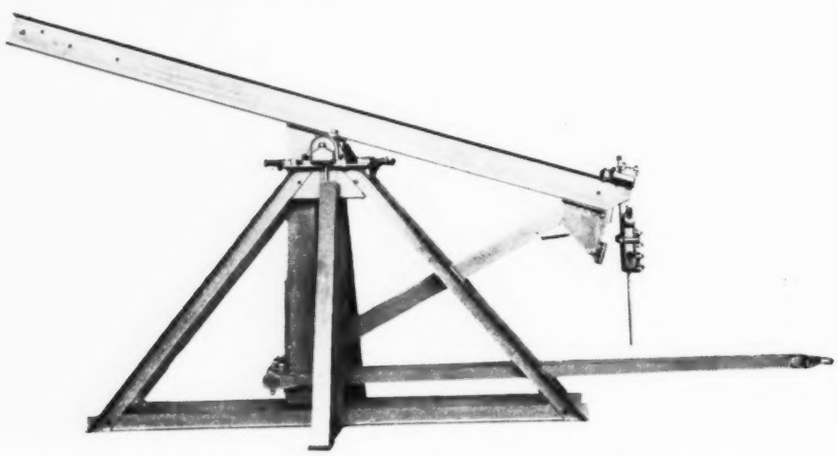
U-8R2

CONTINENTAL SUPPLY CO.
Mid-Continent and Rocky Mountain Distributors

MACHINERY and EQUIPMENT

National Pumping Jack

THE National Supply Company of Delaware, Toledo, Ohio, lately has added to its line of production equipment a new under-pull pumping jack. This is known as the Type D-180 and is designed for the heaviest requirements of present-day rod-line pumping.



The rated dynamic polished-rod load is 18,000 pounds. Rated stroke is 56 inches. Ratios of polished rod to pull rod strokes is maximum 1.81 to 1 and minimum 1.24 to 1. Saddle and pull-bar bearings are bronze bushed with oil reservoirs and perfect oil seals. Steel shafts operating in these bearings are renewable.

The design of the National Type D-180 jack is the same as that of National pumping jacks types D-80, D-100, and D-130-S. Among the more important features are the tri-hedral frame construction (patented) and the adjustable beam mounting (patented). When the beam is mounted on the tri-hedral frame and alignment of polished rod obtained by means of the adjusting screws, there results a structure of great stability that will operate freely and maintain the correct relationship of all parts under the most severe operating conditions, the manufacturers state.

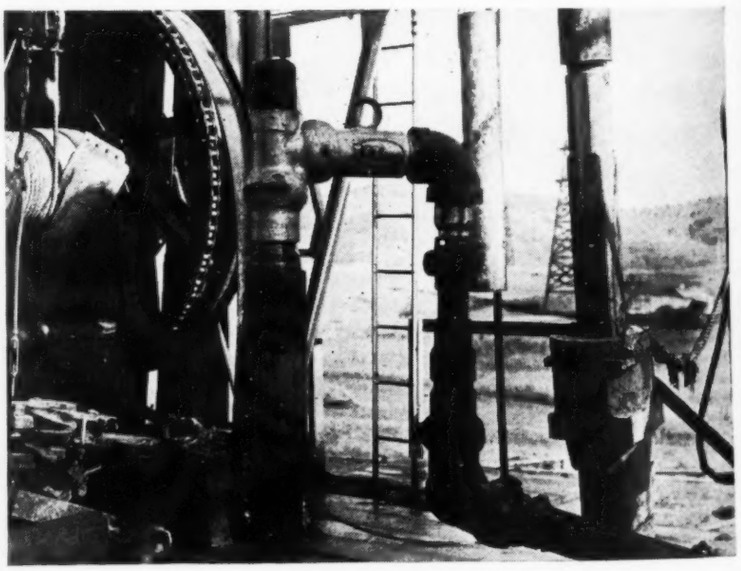
The polished-rod hanger (patented) lifts the polished rod within a fraction of an inch variation from the vertical line. This occurs at the top of the stroke where the angular movement of the rod is almost imperceptible. The linkage does not touch the polished rod except at the clamp and therefore does not impose any bending on this part.

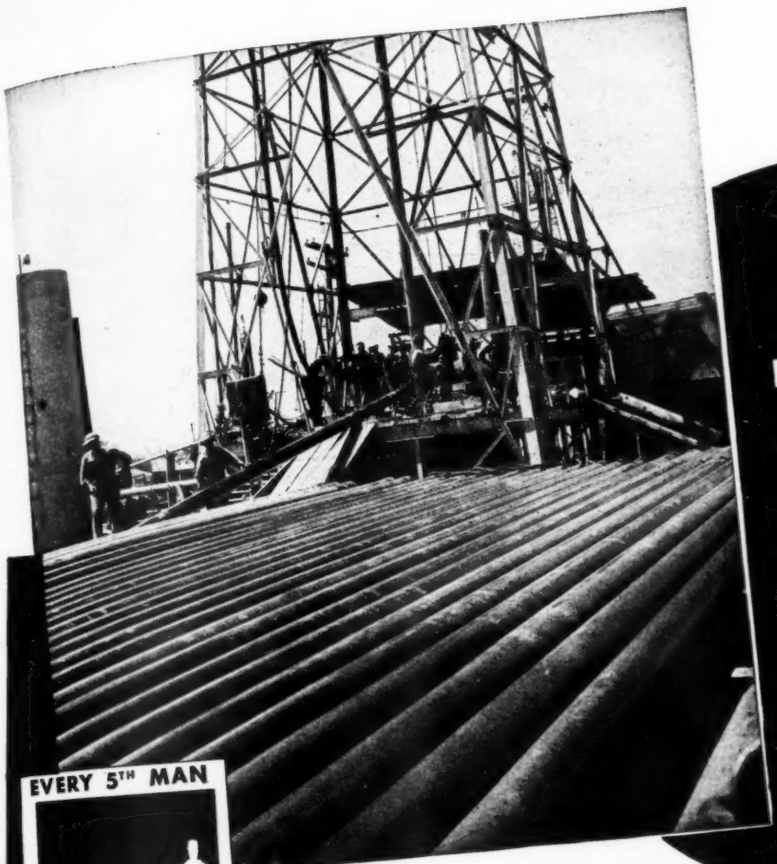
The entire jack is fabricated from structural steel by electric welding. A special feature is the scallop weld (patented) used on both ends of the pull bar. This provides an increased section area at the points of greatest stress, to safely carry the unusually high tensile and bending stresses that occur at these places.

Chiksan "Poor Boy's" Swivel

A NEW device that the manufacturers believe will fill a need in pressure-drilling operations has been placed on the market by Chiksan Oil Tool Company, Ltd., Fullerton, California. It is known as the Chiksan "Poor Boy's" Swivel and is an adaptation of the Chiksan Swing Joint used in the company's cement hose and drilling hose. The "Poor Boy's" swivel connects into the top of the drill pipe or tubing and permits continuous 360-deg. swivelling in both vertical and horizontal planes. Moreover, cast directly into the body of the joint is a tee connection with full-sized opening through which wire-line core barrels, survey instruments, etc., may be raised or lowered in the drill pipe while constant circulation and rotation are maintained. Any standard stuffing-box or oil-saver device may be used in connection with the joint to prevent leakage around the wire line.

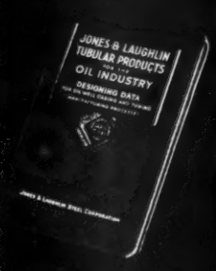
The swivel joint is of all-steel construction and has a working pressure in excess of 3000 lb. per sq. inch. It is available in both 3-in. and 4-in. sizes, and will screw into conventional sub-adapters to be connected into any standard drill pipe thread.





INCREASE YOUR PROFITS WITH J&L STEEL

J&L SEAMLESS CASING cuts your setting time...



Threads are Clean . . . Sharp . . . Accurate

Threads on J&L Seamless Casing are accurate . . . cut with the best in precision equipment. Every thread . . . every length of pipe . . . is carefully inspected, and only highest quality pipe is shipped.

One man out of every five in the Jones & Laughlin Seamless Tube Department works for you . . . as if he were on your payroll. He checks and inspects every length for surface defects, wall thickness . . . diameter . . . out of roundness . . . thread accuracy. Each lot of pipe is thoroughly checked to determine physical and chemical properties.

Thus, with J&L Seamless Casing, the threads engage correctly after stabbing . . . the casing can be spun tight with no delay . . . no galling.

Pipe walls are consistent and uniform with the best of mill practice . . . with adequate strength and weight throughout . . . to safely meet the severe demands of installing and bringing in the well. Long and dependable service is assured . . . your casing crews will like J&L Casing.

Distributors in the oil fields carry a full line of Jones & Laughlin Seamless Steel Tubular Products . . . casing, tubing, drill pipe and line pipe. They deliver the material you need *when* and *where* you want it.

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

MAKERS OF HIGH QUALITY IRON AND STEEL PRODUCTS SINCE 1850

J&L PIPE

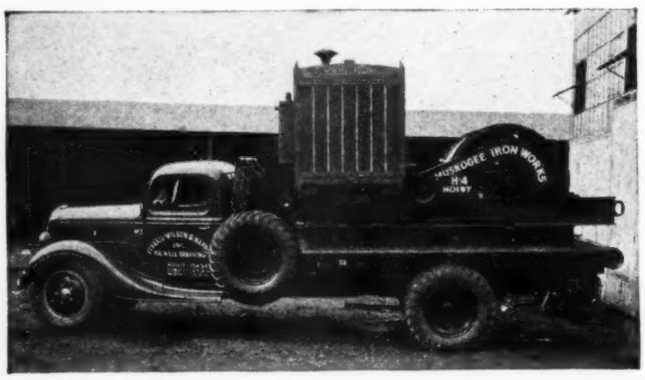
J&L SEAMLESS

DRILL PIPE · CASING · TUBING · LINE PIPE

Muskogee Iron Works H-4 Hoist

THE Muskogee Iron Works, Muskogee, Oklahoma, announces the development of a large well-servicing and drilling unit to be designated as the Model H-4 Hoist.

The hoist shown in the accompanying illustration is equipped



with a Hercules HXE engine, Brown-Lipe 7440 transmission, and high-speed reverse. Spudding attachment, A-frame, auxiliary drum or cathead shaft, and rotary-drive sprocket can be added to convert the well-servicing hoist into a cable-tool or rotary unit.

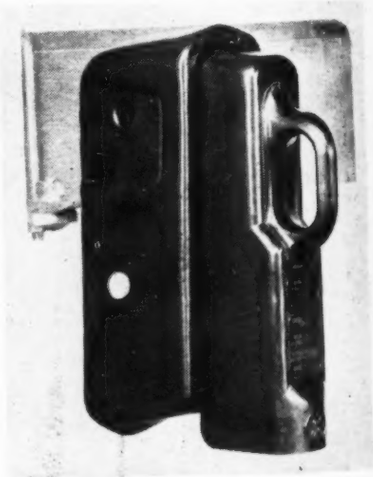
This unit, theoretically, has a line capacity of 9000 ft. of 7/8-in. line and 17,000 ft. of 5/8-in. line. The single line speeds and single-line pulls range from 27,615 lb. at 132 ft. per minute in low to 5717 lb. at 641 ft. per minute in high for an engine speed of 1600 revolutions per minute.

The hoist is equipped with a gas regulator, large gas tank, oilbath gas scrubber, gasoline tank for easy starting, and many other desirable features.

Reclosing Fuse Cutout

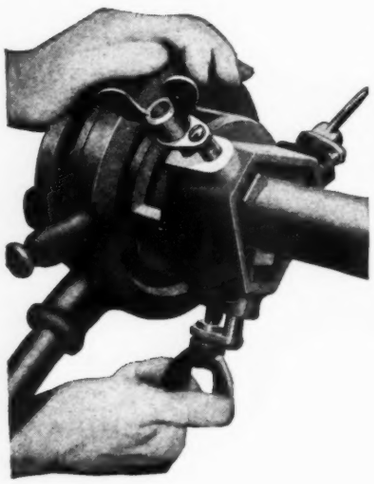
A NEW and different fuse cutout, porcelain-housed, and with reclosing features, has been announced by the General Electric Company, Schenectady, New York. The reclosing mechanism is entirely in the door, which is so constructed that it is interchangeable with the door of present G-E 50-amp. indicating and drop-out cutouts, making it possible to convert the latter into reclosing cutouts by adding the new door.

The reclosing door of the new unit contains two fuse holders. Should the first fuse link blow, the door is pushed outward at the bottom—a positive indication. After a time delay of one second the other fuse holder with its link is connected, thus restoring service if the fault is temporary. Should the second fuse blow, the complete door drops open and is isolated from the circuit.



The reclosing cutout is available in the 50-amp. rating for 5000 volts and for 7500/12,500 GR Y volts; also, the door with the reclosing mechanism is available as a separate item.

A 1" to 2" THREADER



... that is unequalled for use in the field.

No bushings. Three broad-faced chuck jaws with large wing-head thumb screws and size-marked guide bars make this tool easy to center on the pipe. Long life pipe holder. Minimum wear.

Die receding principle and separate set of dies for each size assures good threads and easy operation.

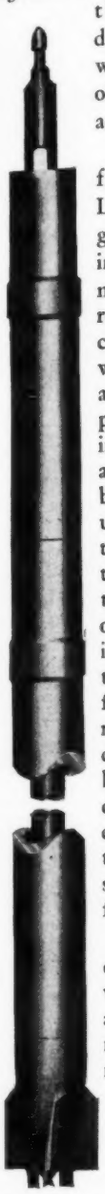
The "TOLEDO" No. 1BR threads 1", 1¼", 1½", and 2" pipe. Sold by leading Oil Well supply dealers. Catalog covering complete line sent on request.

THE TOLEDO PIPE THREADING MACHINE COMPANY
TOLEDO, OHIO NEW YORK OFFICE, 72 LAFAYETTE STREET

"TOLEDO"
EFFICIENT EASY OPERATING

Elliott Wire-Line Retractable Core Drill and Drilling Assembly

THE Elliott Wire-Line Core Drill and Drilling Assembly is one of the most modern developments in coring tools that will prove of interest to the petroleum industry, due to the fact that the wire-line method of coring oil wells offers important advantages to operators.



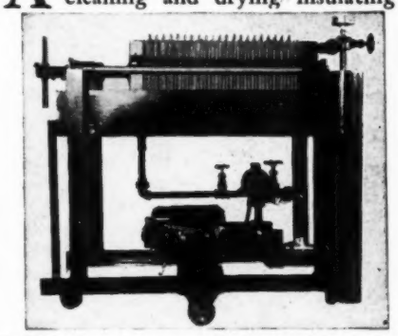
According to the manufacturer, the Elliott Wire-Line Core Drill is distinguished by three outstanding features that co-ordinate to cut faster hole and recover an increased percentage of clean, true core with a minimum of operating difficulty and expense; viz: (1) the novel inner barrel valve that creates a suction on the inner barrel to aid the entry of unconsolidated cores; (2) the improved cutter heads that discharge the circulation closer to the bottom of the hole while protecting the core from circulation wash, which results in faster drilling and much more hole before becoming dull; and (3) the inner barrel that requires no driving mechanism and embodies no moving parts, thereby assuring maximum simplicity and freedom from operating difficulties.

Among the advantages claimed for the Elliott wire-line method of coring are the savings in time and money through the elimination of many round trips of the drill pipe. This minimizes wear on the drill pipe, tool joints, drilling lines, brakes and drawworks. Also, protective mud coatings on the walls of the hole are maintained in better condition, it is stated.

Detailed specifications covering these various assemblies, together with complete descriptions, illustrations, and operating procedure, are given in Bulletin 37-W just issued by the manufacturer. A copy may be obtained by addressing the Elliott Core Drilling Company, general offices at 4731 East 52nd Drive, Los Angeles, California; or the export office at 420 Lexington Avenue, New York City.

Oil-Filter Press

A NEW line of oil-filter presses for cleaning and drying insulating oils has been announced by the Westinghouse Electric and Manufacturing Company. These presses are light in weight, have low power consumption, and are quiet in operation. Their features include a pump bypass through a ¼-in. needle valve to test the suction line for leaks; a small tank providing a primary gas trap; a discharge flow taken from the bottom of the filter sections providing a secondary gas trap. All unions are of the railroad brass insert type. Standard outfits are rated 5, 10, and 30 gal. per min. for 60-cycle, 220-volt supply.



TRY AND BEAT THIS LINING FOR WEAR!

THIS RIG, owned by the firm of Golden and Farris, and being used in the Corpus Christi oil fields, Texas, was re-equipped with J-M Giant Rotary Lining, Style 410. The superior, dependable service of this unusually durable material assures continued high braking effectiveness here and on all similar rigs.

You get all these advantages on your drilling rigs—with J-M Lining, Style 410

AN EVEN FEED-OFF
. . . assuring better controlled drilling.

LESS SMOKING AND DUSTING
. . . working conditions greatly improved.

SCORING TENDENCY REDUCED
. . . life of brake rim is lengthened.

QUIETER BRAKES
. . . less nerve strain on drilling crews.

Johns-Manville
GIANT ROTARY LINING
Style 410
JM

FOR FULL DETAILS on the complete line of J-M Friction Materials, address Johns-Manville, 22 East 40th Street, New York City.

DEEP CORING

with Quick Accurate Results is assured with the

HUNT

Retractable Barrel

Nobody knows, better than the Contractor, how coring failures take the profit out of a deep hole . . . and nobody knows, better than the Contractor, the many advantages of the HUNT WIRE LINE BARREL, especially where great depths are drilled. Hard and Soft formation heads interchangeable.

•

Ask for Descriptive Literature.

•

Rental Service in U.S. For Sale Foreign.

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HUNT TOOL COMPANY
HOUSTON, TEX.
Formerly AUTHORIZED APPLEMAN BIT SERVICE CO.
HUNT WIRE LINE CORE BARRELS

BIT SERVICE SHOPS:
Houston, Joinerville, Talco, Corpus Christi, Bay City, Alvin, Texas . . . . Rodessa, Jennings, Houma, Louisiana

STRAIGHT TALK.... about CROOKED HOLES

Write for literature

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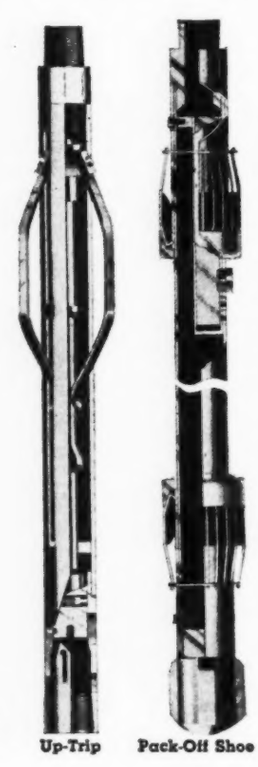
425 Petroleum Building, Tulsa, Okla.
3118 Blodgett Avenue, Houston, Texas
549 East Bixby Road (3800 Block—Atlantic Ave.) Long Beach, Calif.
Bank of Lafayette Bldg., Lafayette, La.
c/o Elks Club, 17th and I Streets, Bakersfield, Calif.

Cavins Perforation Washer

THE Cavins Company, Long Beach, California, has announced the completion of arrangements with its branches and agencies throughout the country for the handling of the Cavins Perforation Washer, now being made available for the first time to the industry outside of California.

The Cavins Perforation Washer is made up by combining the pack-off shoe and the up-trip attachment with the Cavins automatic hydraulic suction bailer. The up-trip attachment is assembled to the Cavins bailer near the top. This device makes it possible to load the tool at any desired point in the well simply by raising the entire assembly. The pack-off shoe is assembled to the bottom of the bailer, and restricts the loading of the tool to that point in the perforations between the pack-off rubbers.

Utilizing the hydraulic pressure of the fluid column in the well, the perforation washer draws sand, mud, shale, and other contaminating material from behind the pipe, through the perforations, and into the tool via the pack-off shoe, where it is trapped to be brought to the surface. A certain amount of material that has been loosened, but not recovered in the tool for removal to the surface, will settle to bottom during operations. After washing operations have been completed, it is a simple matter to remove the pack-off shoe and the up-trip and recover this material with the bailer.


Up-Trip Pack-Off Shoe

PETROLEUM REFINERY EQUIPMENT SALES ENGINEER—Prominent manufacturer will add to its sales staff a qualified sales engineer, thoroughly experienced in refinery equipment. State all particulars in first letter. Address Sales Engineer, Box 1589, Dallas, Texas.

JENSEN UNITS GOOD?

Why Wouldn't They Be!

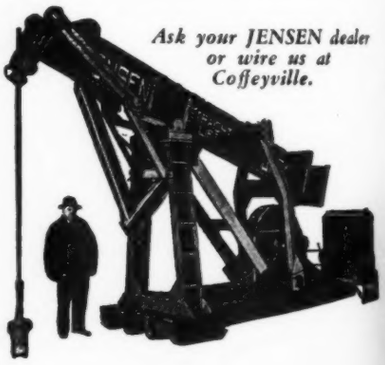
NINETEEN YEARS with nothing to do but design, manufacture, study and perfect pumping equipment!

NINETEEN YEARS of enthusiastic co-operation from successful producers!

NINETEEN YEARS of steady growth and progress!

Why wouldn't JENSEN Straight-Lift PUMPING UNITS be good? There's nothing like 'em for dependable, inexpensive performance.

Ask your JENSEN dealer or wire us at Coffeyville.

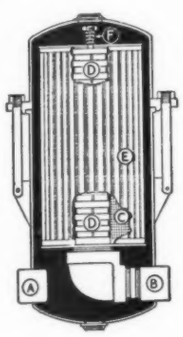


JENSEN BROTHERS MANUFACTURING CO.

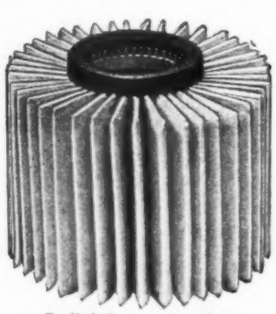
. . . Coffeyville, Kansas

Liquid Line Filter

THE new Protectomotor liquid-line filter, Model CPHL, manufactured by the Staynew Filter Corporation, Rochester, New York, is said to be ideally suited for the economical and highly efficient filtration of lubricating oil to Diesel and other internal combustion engines.



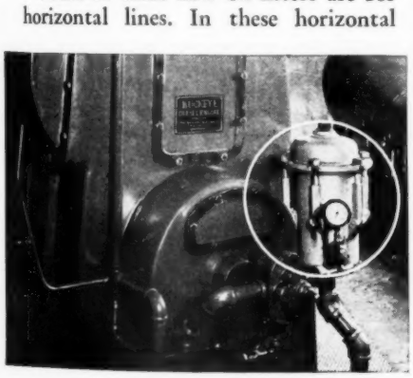
The well-known Protectomotor principle of radial fin construction is employed. (See illustration.) This principle permits an unusually large area of filtering medium to occupy a relatively small space; for example, a Protectomotor radial fin construction



Radial fin construction.

insert only 11 in. high by 8¼ in. in diameter has an active filtering area of 1325 sq. inches.

Most of these new oil filters are for horizontal lines. In these horizontal



Diesel installation.

line models a drain plug in the bottom half of the filter shell can be removed for draining. They may be opened quickly for inspection or cleaning. This is done either by loosening the fasteners in the case of swing-bolt models or by unscrewing the locking lugs on the bolted models. Cleaning is a simple matter. It is only necessary to remove the filter insert, dip it in gasoline and scrub with a soft brush.

The cut-away outline drawing illustrates construction features. (A) and (B) are inlet and outlet, respectively, in standard pipe sizes; (C) is the wire mesh frame of the radial fin construction; (D) the reinforced core; (E) the filter insert and (F) the retaining spring. The low-pressure model is essentially of the same construction but without reinforced core or retaining spring. Sizes and models are made for almost unlimited capacities and pressures. This model will accommodate 125-lb. pressure.

The photograph showing a Protectomotor Model CPHL in use is on a new 187½-hp. Buckeye Diesel operating at 400 revolutions per minute. No other device except this Protectomotor filter is used to clean the oil.

Q. What is the cost of a string of cable tools?

A. The value of the service rendered by the tools.

THE value of a set of cable tools is not determined by the initial cost. It's what you get for your money that counts.

Measured by this yardstick, Spang Cable Tools are the most economical tools you can use. Every cent of your investment is doubly returned in strength, efficiency, and length of service.

Refer your cable-tool problems to Spang & Company, and put our extensive experience to your own use.

SPANG & COMPANY
BUTLER, PENNSYLVANIA

PROSSER-TYPE ROPE SOCKET
Fig. 505

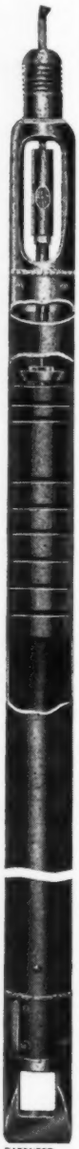
Specify Spang
"HIGHER-STANDARD" CABLE TOOLS

Remove the Sand
FROM YOUR WELLS

AND PLAY ON THE SAND AT THE BEACH

Removing the sand and sediment from your wells with a MILLER will increase their production, giving you more money to vacation at the beach.

The MILLER is made in diameters of 2½, 3, 3½, 4, 4¼, 5, 5½, 7 and 9 inches and lengths of 20, 25 and 30 feet. 5/32-inch wall thickness in REGULAR Type, ¼-inch wall tubes HEAVY Type Sand Pumps.



INTERCHANGEABLE BOTTOMS
To Meet Every Condition

● **BAILER BOTTOM**
With the Bailer Bottom installed the MILLER is quickly changed to a Bailer giving you a combination of either Bailer or a Sand Pump in one tool.

● **SAND BOTTOM**
Used when tools are run and when well is shot to quickly remove loose material.

● **STAR BOTTOM**
Used for cutting the sand loose.

● **CHISEL BOTTOM**
(In Pump)
With this bottom tightly packed sand can be easily broken in small pieces so it can be picked up in the pump.

Write for Descriptive Folder and Price List

See Page 1186 COMPOSITE CATALOG

PATENTED
NO. 1370340
NO. 1523604
NO. 1787390
NO. 1892628
NO. 1964028
NO. 2055667

MILLER
Sand Pump Co.

General Offices and Shop, Box 4516
OKLAHOMA CITY, OKLA., U. S. A.

Branch Shops and Offices:
SAPULPA, OKLA. and KILGORE, TEX.

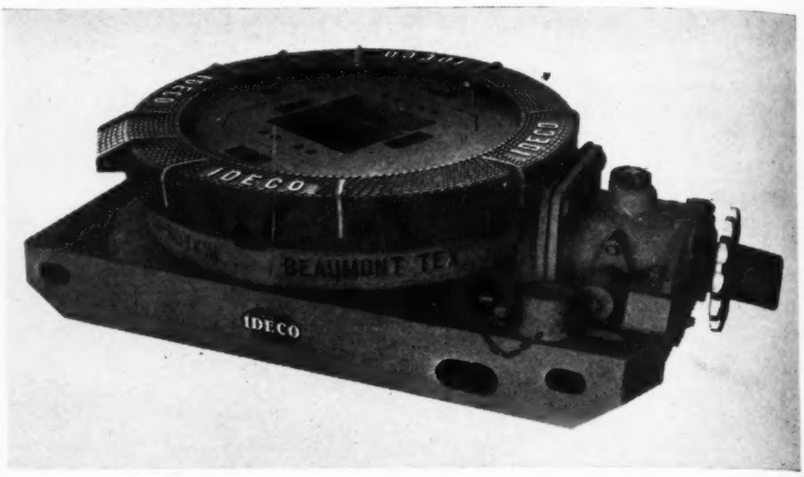
FOR SALE BY SUPPLY STORES EVERYWHERE

Ideco 27½-in. Bobtail Oilbath Rotary Machine

THE International Derrick and Equipment Company offers to the oil industry a new 27½-in. Oilbath Rotary that incorporates the most modern design plus several outstanding features, the manufacturers state.

The construction features are as follows:

The rotary base and all heavily-stressed castings are of chrome-nickel alloy steel.



The rotary is equipped with a low perfectly flat table that is completely encircled by a heavy cast-steel guard having a non-skid surface.

The main bearing races are hardened by a special process to more than 600 Brinnell.

The pinion shaft is mounted in two self-aligning S.K.F. combination radial and thrust bearings, which allow a universal movement of the pinion shaft.

The pinion shaft drive sprocket is of chrome-nickel heat-treated steel with machine-cut teeth.

The lubrication is fully enclosed oilbath. The bearings and gears are sealed to insure no contamination of the lubricant by mud or other foreign substances. Any matter that might get into the oil is carried to a deep oil sump and filtered out. The pinion-shaft bearings are enclosed in a "capsule" entirely separate from the housing of the table bearing, and each of these has its own separate oil reservoir.

This rotary has a dead load capacity of 300 tons, which allows it easily to handle the maximum depth of present-day drilling.

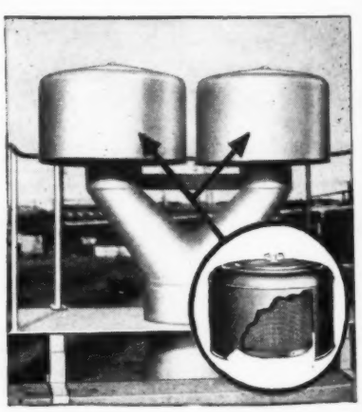
Multimaze Air Filter

AMONG the various types of air filters available today is one that might well be called an "all-purpose" unit. It is the Multimaze air filter manufactured by the Air-Maze Corporation, 812 Huron Road, Cleveland, Ohio. A typical exterior multiple installation of two hooded Multimaze units is illustrated. Construction details are seen in the inset.

The Multimaze is a compact, cleanable metal-fabricated air filter of patented construction. It is obtainable in various sizes for internal combustion engines, air compressors, blowers, and air-conditioning systems. Air-cleaning efficiency is claimed by the manufacturer to be better than 99 percent, restriction less than ⅛-in. H_2O. A Multimaze installation requires a small amount of space even when the application demands thousands of c.f.m. per minute. Servicing is simple.

For certain types of air-conditioning installations the Multimaze units are particularly suitable, the makers state.

The Multimaze filter element media may be especially constructed so that



air-cleaning problems where lint or other disturbing factors are present may be circumvented easily. Flame arresting characteristics of the elements have been approved by the National Board of Fire Underwriters and Factory Mutual Laboratories.

"For Flying Trips"

If you call a branch office of Pittsburgh Equitable Meter Company about some urgent problem pertaining to gas measurement or pressure regulation and they reply that they will make a "flying trip" to see you, be prepared. For a "flying trip" is exactly

Captain A. E. Higgins

what they mean, and the man will be Captain A. E. Higgins, vice-president of the company.

Captain Higgins pilots his plane, a new four-place cabin Stinson, from coast to coast.

New Republic Distributors

Four new distributors for Republic's tubular products have been announced by N. J. Clarke, vice-president in charge of sales of Republic Steel Corporation, Cleveland, Ohio. They are: The Bluefield Supply Company, Bluefield, West Virginia; Ormand Plumbing Supply Company, San Antonio, Texas; J. Gaber Company, Houston, Texas, and Morgan's Inc., Savannah, Ga.

District Office at Tulsa

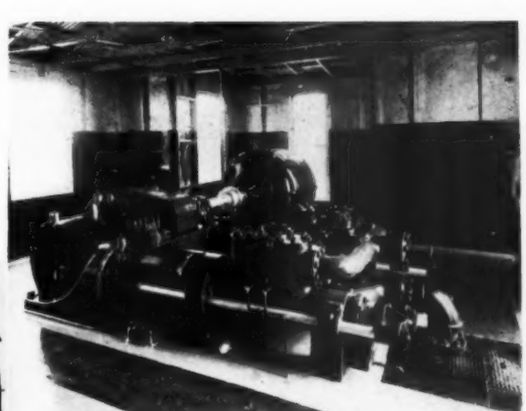
The Jones & Laughlin Steel Corporation announces the establishing of a district sales office in Tulsa, Oklahoma, and have appointed Carl E. Swindler as the district sales manager in charge. Mr. Swindler has been employed by J. & L. for a number of years and during his service has always been identified with that particular territory.

90% *Purchased*

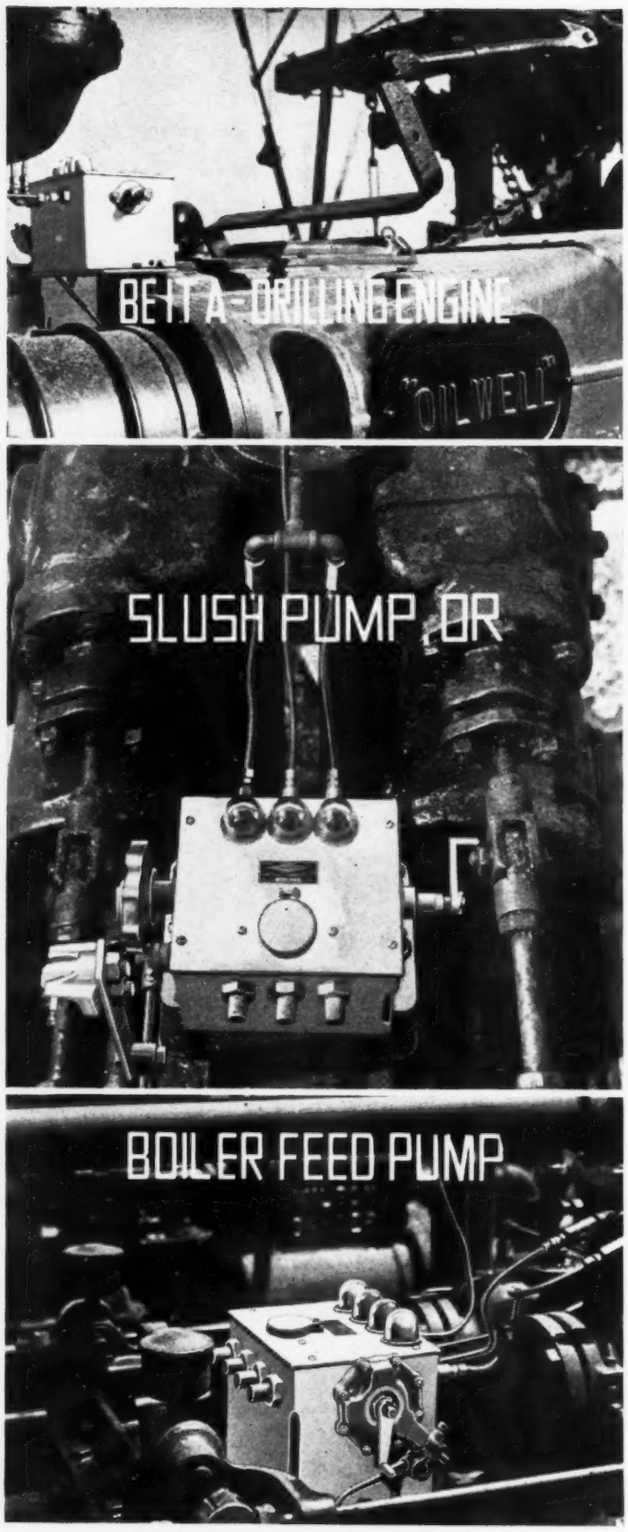
ELECTRIC POWER

There's often a difference of opinion about many things, but there *isn't* much difference of opinion among the operators in the Pierce Junction oil field concerning the best kind of power to use, since 90% of the total horsepower installed in that field is operated on DEPENDABLE PURCHASED ELECTRIC SERVICE.

It will pay you to investigate the reasons why!



HOUSTON LIGHTING & POWER COMPANY



IT HAS DEPENDABLE LUBRICATION IF IT'S EQUIPPED WITH A "STANDARD"

"STANDARD" Lubricators are made in 1- to 10-feed models to deliver ½ pint to 2 gallons of oil per 24-hour day from each feed. For complete details refer to Pages 101-103, your 1937 Composite Catalog, or write American Lubricator Co., First National Bandk Bldg., Dallas, Texas.

"STANDARD" LUBRICATORS

Progress of Houston Oil Show Told

In an address before the Houston Advertising Club, John R. Suman, vice-president of the Humble Oil and Refining Company, presented some interesting data relative to the oil activities around Houston and the purpose of the Oil-World Exposition, Inc., of which he is president. The first oil show to be given under this management will be held in and around the new Jesse H. Jones Coliseum in Houston from October 11 to 16, inclusive.

In stating the purposes of the Oil-World Exposition, which is a non-profit corporation consisting of some 350 members drawn from the outstanding oil companies, supply companies and manufacturers, Suman quoted from the by-laws as follows: "The purposes and limits of the activities of this association are, in a broad sense, educational, and shall comprise the collection, study and dissemination of factual data with respect to the oil industry in the following particulars: The collection and dissemination of knowledge in relation to the presence and discovery of oil, gas and other minerals; the production, storage, transportation, refining and marketing of petroleum and its products; and the display and exhibition of the mechanical equipment employed in aid thereof."

Suman emphasized that the organization was trying to give the oil industry an outstanding and worthwhile exhibition of modern equipment and in stating his belief that the finest oil show in the world should be held in Houston, presented the following facts to show the importance of the exposition's location. "Houston," said Suman, "is the greatest oil town in the world as is easily proven by the following pertinent statistics: Proven reserves of crude oil within 100 miles of Houston comprise a total of at least two billion bbl., which is 28 percent of all the known reserves in Texas, 15 percent of the reserves of the United States and seven percent of all the known reserves of the world. Besides being so favorably situated in respect to oil reserves, there are also reserves of gas amounting to two and one-quarter trillion cu. ft., or approximately 14 percent of the state's gas reserves. Houston is the largest concentration point in the world for oil well supply companies. Houston is headquarters for more than 500 oil companies and allied industries, giving direct employment to 40,000 people.

"The oil industry is the biggest customer of incoming and outgoing freight. The advantages of Houston as a port were early recognized and as a consequence this city has become a very important refining and concentration center. There are nine refineries directly connected with the Houston Ship Channel, and they are currently running around 280,000 bbl. of oil daily, and, in addition, 150,000 bbl. daily of crude oil is shipped via tankers. This total tonnage, shipped via our Ship Channel, comprising 430,000 bbl. daily, approximates 30 percent of all the oil produced in Texas. Oil is delivered by pipe lines to Houston from the states of New Mexico, Oklahoma, Kansas, Texas, Arkansas, and Louisiana. In addition to the pipe-line movement, tank cars bring more supplies. Houston is one of the largest cotton ports in the world, but you must bear in mind that 84 percent of the tonnage of 21,250,000 long tons moved from Port Houston for the year 1936 was petroleum and its products."

A housing committee has been created by the Houston Chamber of Commerce to take care of the many thousands of visitors to the Oil-World Exposition. This action has become necessary in order to make certain that comfortable accommodations are made available without delay and inconvenience upon the arrival of those attending the show. A number of the leading hotels are completely filled up with reservations for the week of the Exposition, although some of the larger hotels are still accepting reservations.

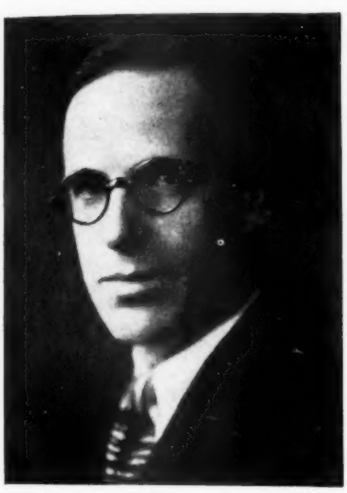
Armstrong Joins Texas Steel

A. J. Armstrong has resigned as secretary of the Association of Producers of Petroleum of Mexico to become vice-president of the Texas Steel Company, Fort Worth, Texas. His duties will be those of executive officer in charge of the oil-field activities.

A. J. Armstrong

Armstrong, whose resignation was effective August 1, has a wide acquaintance with oil operators in the Southwest, due to his association with the business over a period of 19 years. He was operating in the old Desdemona field when it first became active, and he left there to join the Gulf organization at Tampico. He was later district superintendent for the Gulf on the Isthmus of Tehuantepec. Armstrong left the Gulf organization in 1922 to become secretary of the Association of Producers of Petroleum of Mexico.

C. J. Coberly in Mid-Continent



C. J. Coberly

C. J. Coberly, president of Kobe, Inc., Los Angeles, is on one of his many business trips to Oklahoma City, since the opening of the company's branch at 3119 South Robinson Avenue in that city. He will spend about two weeks making a tour of inspection of the Kobe hydraulic pumps installed in that district, and taking care of other business matters concerning the Oklahoma City branch in cooperation with C. M. Rader, branch manager.

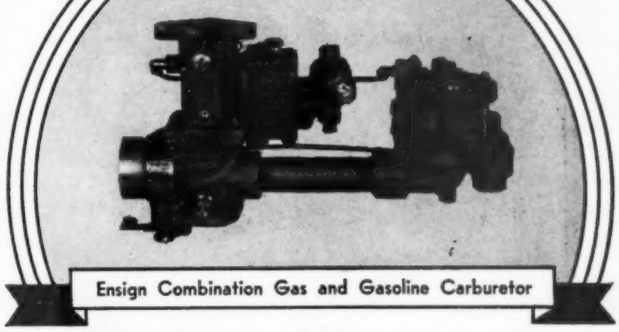
Bert L. Stone to Europe

Bert L. Stone, vice-president and general manager of the Hydril Company, left Los Angeles on July 21 en route to New York whence he sailed for England on August 4. He stopped off on his way to New York to inspect the branch factories of the Hydril Company in Youngstown, Ohio, and Rochester, Pennsylvania.

Stone will be in London and The Hague until the first part of September, when he will return to the United States.

Bert L. Stone

ENSIGN



Ensign Combination Gas and Gasoline Carburetor

Back of the name Ensign is a long record of important achievement. For more than 25 years it has symbolized high quality, fine precision carburetors and fuel regulating equipment of the most advanced type. Ensign equipped power units are efficient and dependable for all classes of service.

ENSIGN CARBURETOR CO., Ltd.
Huntington Park ◆ California
Branches: Chicago, Illinois; Dallas, Texas

FRANKS UNIT FASTER

Because Hydraulics 2 to 4 Times Longer

Franks' Combination Portable Rotary and Core Drill with Hydraulic feed (Hydraulics 16'-10" stroke) is made in four models for exploration drilling; coring up to 4,000 ft.; production drilling up to 3,500 feet; drilling input water wells, etc. Franks' faster, easier operation permitted a 40 per cent per foot reduction over previous costs in Kansas. Write for complete information or a demonstration.

FRANKS MFG. CORP.
WELL SERVICING AND DRILLING UNITS

P. O. Box 137, Whittier Station Tulsa, Oklahoma
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SAVES *time and labor. Run in on sucker rods, seats in installed working barrel.*

PREVENTS *sanding. Can be unseated for repairs without damage to cups.*

LOWERS *power consumption and reduces rod stress. Outer tube is the moving part.*

LASTS *longer, because of improved design and precise manufacture.*

The Huf-Duo Insert Pump is made for 2", 2½" and 3" tubing. Carried in stock by oil-field distributors. The Charles N. Hough Mfg. Company, Franklin, Pa., and Tulsa, Oklahoma.

HUF-DUO Insert Pump

Easy to Deliver—
Easy to Install—
Safe Against Meddling

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FULTON
Spring-Type
REGULATOR

EASILY transported, easily installed, self-protecting against accident or meddlers, you'll often find the Fulton Spring-Type Regulator preferable to one of the lever type for use in exposed, out-of-the-way places. Designed for high-pressure service as here shown, reduces from 300 pounds to any pressure between 10 and 50 pounds. Designed for low-pressure service, reduces inlet pressures as high as 50 pounds to outlet pressures of one pound or under. Full information given in Bulletin 118, mailed on request.

THE CHAPLIN-FULTON MFG. CO.
28-40 Penn Ave. **Pittsburgh, Pa.**

Book Reviews

Petroleum and Natural Gas Bibliography. By Robert E. Hardwicke. University of Texas, 167 pp. $2.00.

An exhaustive guide to books, bulletins, and indexes in English dealing with petroleum and natural gas; together with a complete listing of articles, notes, and comments relating to the legal phases of petroleum and natural gas appearing in the legal periodicals published in the United States.

This book contains 1397 items of reference, all alphabetically arranged as to authors and accurately divided into sections dealing with General and Historical, Finding and Prospecting, Development and Production, Transportation and Storage, Refining and Testing, Marketing and Utilization, Economics and Statistics, Legal, U. S. Governmental Reports and Findings of a Political Nature, Accounting and Finance, and Bibliographies, Indexes and Publication Lists. It covers the period from the year 1861 to January 1, 1937, and hence should prove of great value as a source book for all branches of the petroleum and natural gas industries.

The author is a widely-known authority on oil and gas law and specializes in the economic and legal phases of oil and gas conservation. He also is special lecturer on petroleum economics at the University of Texas. His efforts in the preparation and publication of this much-needed book are especially laudable in that all the profits from the sale of the volume are being dedicated by him to a fund to be devoted to the extension of the library on petroleum and natural gas at the University of Texas in order that students, workers, and the general public may have access to the accumulated written knowledge on these subjects.—M. J. Leahy.

Trade Personals

L. L. THOMAS, mechanical engineer, is now connected with the Bradford Motor Works, Bradford, Pennsylvania, as field engineer, and will make his headquarters in the Tulsa, Oklahoma, office of the company. Thomas is a graduate of the University of Pittsburgh, and for the past several years has been associated with the Gulf Research Laboratories at Pittsburgh.

●

OWEN C. JONES has been made assistant to the president and in charge of sales promotion of the Laminated Shim Company, Inc., Long Island City, N. Y., manufacturers of Laminum precision adjustment shims. For the last six years he has been associated with the general publicity department of The Linde Air Products, a Unit of Union Carbide and Carbon Corporation.

●

ALEXANDER ANDERSON, of Fullerton, California, who recently sold his company, Alexander Anderson, Inc., to the Lane-Wells Company, is spending the summer in Europe. His present address is 103A Sinclair Road, London, W. 14, England.

●

E. R. GALVIN, general sales manager of Caterpillar Tractor Company announced three sales department changes, effective at once. PAUL WEEKS, who was manager of the Washington, D. C., office until his transfer to the Peoria offices about two years ago, returns to Washington, relieving E. B. ENGLISH, who as a newcomer to Peoria will become

manager of federal and state sales. H. H. HOWARD, who has been in the employ of the company since 1926 in export and domestic sales capacities, has been appointed manager of the engine sales division.

●

CHAS. GEDDES is now representative at Midland, Texas, for the Shaffer Tool Works of Brea, California.

●

T. S. JONES, formerly of the Tulsa, Oklahoma, branch of Crane Co., Chicago, and an employee of the company for many years, has been transferred to the oil sales department as a field representative covering the states of Kansas, Oklahoma, and the Panhandle of Texas.

●

LEWIS H. BROWN, president of the Johns-Manville Corporation, has anounced that E. S. CROSBY has been named president of the Johns-Manville International Corporation, a subsidiary.

C. C. McDermond Marries Texas Girl

C. C. McDermond of Maracaibo, Venezuela, South America, recently was married to Miss Ida X. Lindsey. Miss Lindsey, whose home is in Texas, was a nurse at the Gulf Hospital in Maracaibo. McDermond is well known and liked through Venezuela, being representative in the area for a number of North American manufacturers.

G. W. Moore Promoted

G. W. Moore

Paul Cavins, general manager of the Cavins Company, manufacturers of the Cavins automatic hydraulic suction bailers, announces the appointment of G. W. (Waldo) Moore to the position of manager of California rental service agencies and national advertising. Prior to assuming his new duties, Waldo had represented the company in a sales capacity in the Los Angeles Basin.

McPhee Joins Lane-Wells

Effective August 2, James W. McPhee became associated with the Alexander Anderson Division of Lane-Wells Company as sales engineer. McPhee has been connected with the oil industry and supply business for nearly 15 years, starting as an electrician for Shell at Signal Hill. In 1923 he was transferred to the engineering department. He majored in development work on water entry problems.

In 1928 McPhee left Shell to organize the Snap Valor Corporation. From 1931 to 1936 he acted as factory representative for U. S. Electrical Manufacturing Co., specializing in the application of electrical motors to oil production. In 1936 he went with Midwest Piping and Supply Company, where he remained until he resigned to accept his present position.

Gotkool
WATER CANS
& COOLERS
GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non leaking push button faucet. Your Supply Store has them, get one today! . . . . .
Gott
GOTT WATER CAN
Made in 1½, 3, 5, and 10 gallon sizes
H. P. GOTT MFG. CO.
WINFIELD, KANSAS
KEEP PURE DRINKING WATER ALWAYS HANDY

Look for the Arm-and-Hammer
ARMSTRONG BROS.
Heavy Duty PIPE TONGS
Improved designs give these tongs greater strength and handiness. Jaws are drop forged from special steel; are heat treated, hardened and tested for wearing qualities. Chains are proof-tested to ⅔ catalog strength (3,600 to 40,000 lb.) Handles, forged from high carbon steel, have both stiffness and "spring." Drop forged Chrome-Nickel Shackel. Hardened Bolt. No finer tongs made. All sizes.
Improved
Standard Tongs
Reversible Jaw Tongs
Back-Up Tongs
Break-Out Tongs
ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
331 N. Francisco Avenue, CHICAGO, U. S. A.
Eastern Warehouse and Sales: 199 Lafayette St., New York, N.Y.
San Francisco
London
Write for Catalog.

Only a limited number of copies of the June issue, containing the first installment of "THE PETROLEUM ENGINEER'S CONTINUOUS TABLES" are now available.

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THE *Petroleum* Engineer's

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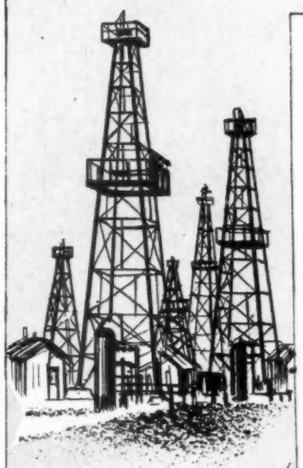
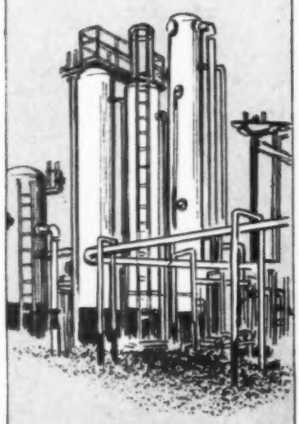
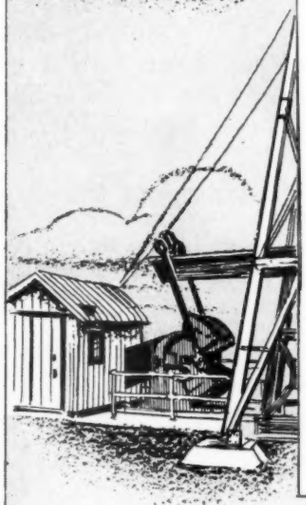
A DAILY REFERENCE FOR OPERATING MEN

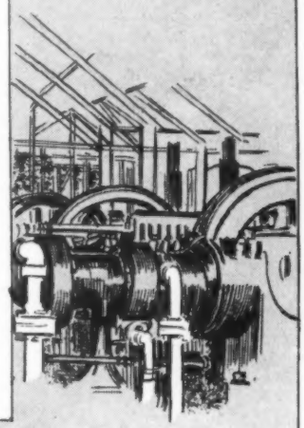


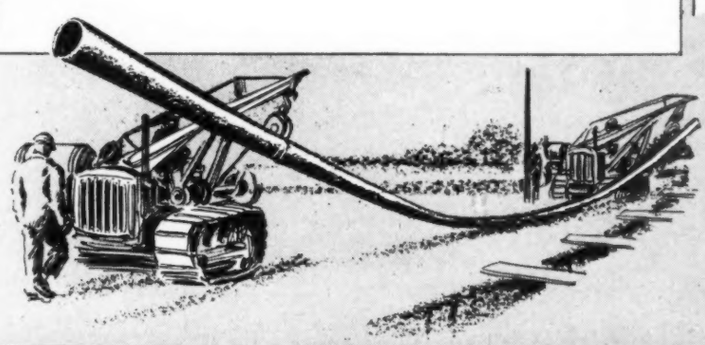


INSTALLMENT No. 3

IN publishing this series of tables THE PETROLEUM ENGINEER is endeavoring to meet the diverse needs of a large number of readers employed in all branches of the oil industry. At present the number of tables published for each division reflects as well as can be determined the relative demand for material applicable to that division. Comments and suggestions from readers are cordially invited, for the more of these that are received the more closely will the editors be able to gauge the readers' interest.







A REGULAR FEATURE OF THE *Petroleum* Engineer

Engineering Data Especially Compiled for Office, Field and Plant Use

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(This index supersedes the index in the July issue)

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Piston displacement and rated horsepower for 4-cylinder motors	P 094.843.4	259	August
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*This index is revised monthly as additional tables are published.
[a]In footnote, "feet" should read "inches".

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Trinity Portland Cement Company	118	July	P 444.
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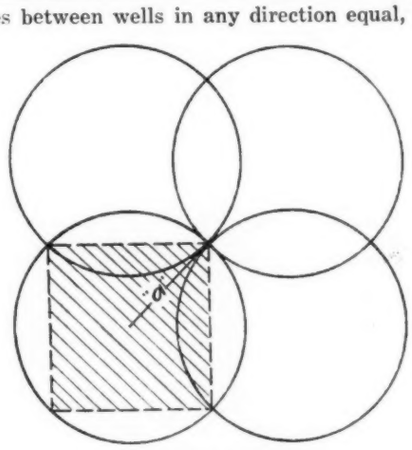
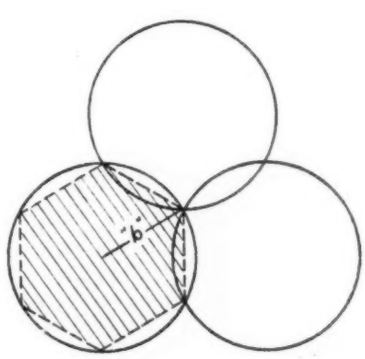
DRAINAGE BY UNIFORMLY SPACED WELLS

Spacing, ft.	Area drained, acres per well		Maximum drainage distance, ft. (see diagrams)		Spacing, ft.	Area drained, acres per well		Maximum drainage distance, ft. (see diagrams)	
	Regular	Staggered[1]	Regular "a"	Staggered "b"		Regular	Staggered[1]	Regular "a"	Staggered "b"
60	.083	.072	42.4	34.6	560	7.20	6.23	396	323
70	.112	.097	49.5	40.4	570	7.46	6.46	403	329
80	.147	.127	56.6	46.2	580	7.72	6.69	410	335
90	.186	.161	63.6	52.0	590	7.99	6.92	417	341
100	.230	.199	70.7	57.7	600	8.26	7.16	424	346
110	.278	.241	77.8	63.5	610	8.54	7.40	431	352
120	.331	.286	84.8	69.3	620	8.82	7.64	438	358
130	.388	.336	91.9	75.1	630	9.11	7.89	445	364
140	.450	.390	99.0	80.8	640	9.40	8.14	452	370
150	.517	.447	106	86.6	650	9.70	8.40	460	375
160	.588	.509	113	92.4	660	10.0	8.66	467	381
170	.663	.575	120	98.2	670	10.3	8.92	474	387
180	.744	.644	127	104	680	10.6	9.19	481	393
190	.829	.718	134	110	690	10.9	9.47	488	398
200	.918	.795	141	115	700	11.2	9.74	495	404
210	1.01	.877	148	121	710	11.6	10.0	502	410
220	1.11	.962	156	127	720	11.9	10.3	509	416
230	1.21	1.05	163	133	730	12.2	10.6	516	421
240	1.32	1.15	170	139	740	12.6	10.9	523	427
250	1.43	1.24	177	144	750	12.9	11.2	530	433
260	1.55	1.34	184	150	760	13.3	11.5	537	439
270	1.67	1.45	191	156	770	13.6	11.8	544	445
280	1.80	1.56	198	162	780	14.0	12.1	551	450
290	1.93	1.67	205	167	790	14.3	12.4	559	456
300	2.07	1.79	212	173	800	14.7	12.7	566	462
310	2.21	1.91	219	179	820	15.4	13.4	580	473
320	2.35	2.04	226	185	840	16.2	14.0	594	485
330	2.50	2.17	233	191	860	17.0	14.7	608	497
340	2.65	2.30	240	196	880	17.8	15.4	622	508
350	2.81	2.44	247	202	900	18.6	16.1	636	520
360	2.98	2.58	255	208	920	19.4	16.8	650	531
370	3.14	2.72	262	214	940	20.3	17.6	665	543
380	3.31	2.87	269	219	960	21.2	18.3	679	554
390	3.49	3.02	276	225	980	22.0	19.1	693	566
400	3.67	3.18	283	231	1000	23.0	19.9	707	577
410	3.86	3.34	290	237	1020	23.9	20.7	721	589
420	4.05	3.51	297	242	1040	24.8	21.5	735	600
430	4.24	3.68	304	248	1060	25.8	22.3	749	612
440	4.44	3.85	311	254	1080	26.8	23.2	764	624
450	4.65	4.03	318	260	1100	27.8	24.1	778	635
460	4.86	4.21	325	266	1120	28.8	24.9	792	647
470	5.07	4.39	332	271	1140	29.8	25.8	806	658
480	5.29	4.58	339	277	1160	30.9	26.8	820	670
490	5.51	4.77	346	283	1180	32.0	27.7	834	681
500	5.74	4.97	354	289	1200	33.1	28.6	848	693
510	5.97	5.17	361	294	1220	34.2	29.6	863	704
520	6.21	5.38	368	300	1240	35.3	30.6	877	716
530	6.45	5.58	375	306	1260	36.4	31.6	891	727
540	6.69	5.80	382	312	1280	37.6	32.6	905	739
550	6.94	6.01	389	318	1300	38.8	33.6	919	751
					1320	40.0	34.6	933	762

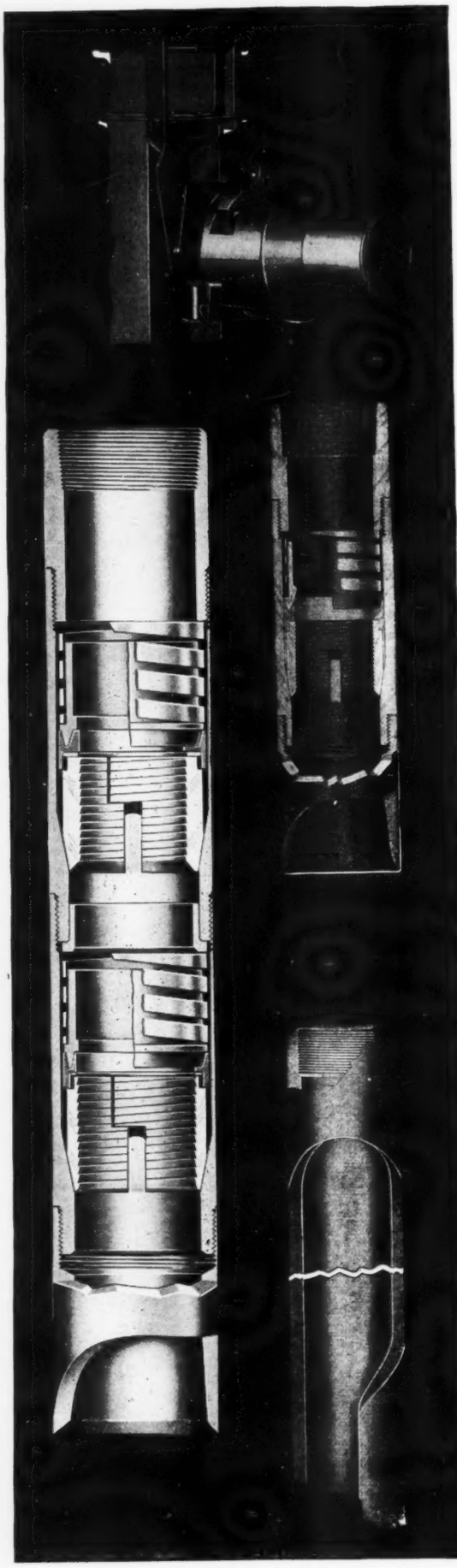
[1]Distances between wells in any direction equal, forming equilateral triangles.



REGULAR SPACING



STAGGERED SPACING



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AMERICAN AUTOMATIC CATHEAD . . .

Because of its greater speed in operation, safety to crew, protection of machinery, and durability, this Cathead has won universal acceptance. Has 4-point engagement and 2-point disengagement. Only nine parts—five of them working parts.

RELEASING AND CIRCULATING OVERSHOTS

There are two types—Regular and Double Bowl types.

The Double Bowl Type Overshot provides you a fishing tool ready at all times to catch both drill pipe or tool joint simply by placing the tool joint slip in the bottom bowl and the drill pipe slip in the upper bowl.

You can convert your Regular Type American Overshot into a Double Bowl Type by adding another bowl and integral parts.

American Wall Hook and Milling Shoes are interchangeable with both the Double and Regular Type Overshots.

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Boltless Rotary Hose Couplings
Cone Fishing Sockets
Casing Suspenders and Blowout Preventers
Drill Collars
Drill Pipe Float Valves
Fishtail Bits
Flow Packers
Milling Shoes
Pumping Well Christmas Trees
Pump Release Valves
Releasing and Circulating Spears
Rocker Arms for Slush Pump
Safety Packing Flanges
Slush Pump Valves and Seats
Steam Lubricators
Sucker Rod Coupling and Paraffin Scraper
Tapered Taps
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Oklahoma City, Seminole and Fittstown, Oklahoma; Houston, Kilgore, Corpus Christi and Monahans, Texas; New Iberia, Louisiana.
Export Office: 420 Lexington Ave., New York City.

MAXIMUM[1] SAFE WORKING LOAD, LB., ON TUBING AND ROD LINES, FRICTION ALLOWED

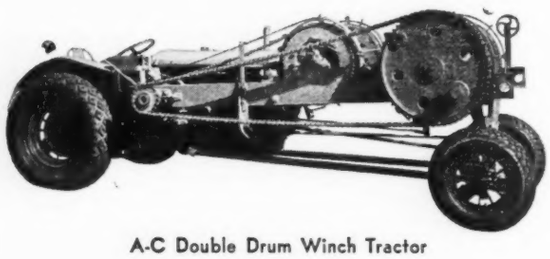
Size of line, in.	Strand	Grade	Number of lines supporting traveling block					
			1	2	3	4	5	6
3/8	6x19	A.P.I. "N"	1,765	3,460	5,080	6,640	8,135	9,565
		A.P.I. "L"	1,960	3,840	5,645	7,380	9,035	10,625
		A.P.I. "J"	2,155	4,225	6,210	8,120	9,940	11,690
		Imp. plow	2,470	4,840	7,115	9,300	11,385	13,390
7/16		A.P.I. "N"	2,355	4,610	6,775	8,855	10,845	12,750
		A.P.I. "L"	2,590	5,070	7,455	9,740	11,930	14,025
		A.P.I. "J"	2,865	5,610	8,245	10,775	13,195	15,515
		Imp. plow	3,295	6,455	9,485	12,400	15,185	17,855
1/2		A.P.I. "N"	3,020	5,915	8,695	11,365	13,920	16,365
		A.P.I. "L"	3,335	6,530	9,600	12,545	15,365	18,065
		A.P.I. "J"	3,685	7,220	10,615	13,875	16,990	19,980
		Imp. plow	4,235	8,300	12,195	15,940	19,520	22,955
9/16		A.P.I. "N"	3,765	7,375	10,840	14,170	17,350	20,405
		A.P.I. "L"	4,155	8,145	11,970	15,645	19,160	22,530
		A.P.I. "J"	4,590	8,990	13,215	17,270	21,150	24,865
		Imp. plow	5,295	10,375	15,245	19,925	24,400	28,695
5/8		A.P.I. "N"	4,625	9,065	13,325	17,415	21,330	25,080
		A.P.I. "L"	5,135	10,065	14,795	19,335	23,680	27,845
		A.P.I. "J"	5,645	11,065	16,260	21,255	26,030	30,605
		Imp. plow	6,510	12,755	18,745	24,500	30,005	35,280
3/4		A.P.I. "N"	6,590	12,910	18,970	24,795	30,365	35,705
		A.P.I. "L"	7,335	14,370	21,120	27,600	33,800	39,745
		A.P.I. "J"	8,080	15,830	23,265	30,405	37,235	43,785
		Imp. plow	9,295	18,210	26,765	34,980	42,840	50,370
7/8		A.P.I. "N"	8,940	17,520	25,750	33,655	41,210	48,460
		A.P.I. "L"	9,960	19,515	28,685	37,490	45,910	53,985
		A.P.I. "J"	10,980	21,515	31,620	41,330	50,610	59,510
		Imp. plow	12,625	24,740	36,365	47,530	58,200	68,440
3/8	6x31 or 6x37	A.P.I. "N"	1,725	3,380	4,970	6,495	7,955	9,350
		A.P.I. "L"	1,920	3,765	5,535	7,230	8,855	10,415
		A.P.I. "J"	2,080	4,070	5,985	7,825	9,580	11,265
		Imp. plow	2,390	4,685	6,890	9,005	11,025	12,965
1/2		A.P.I. "N"	3,020	5,915	8,695	11,365	13,920	16,365
		A.P.I. "L"	3,295	6,455	9,485	12,400	15,185	17,855
		A.P.I. "J"	3,610	7,070	10,390	13,580	16,630	19,555
		Imp. plow	4,155	8,145	11,970	15,645	19,160	22,530
5/8		A.P.I. "N"	4,550	8,915	13,100	17,120	20,965	24,655
		A.P.I. "L"	5,020	9,835	14,455	18,895	23,135	27,205
		A.P.I. "J"	5,490	10,755	15,810	20,665	25,305	29,755
		Imp. plow	6,315	12,370	18,180	23,765	29,100	34,220
3/4		A.P.I. "N"	6,430	12,600	18,520	24,205	29,645	34,855
		A.P.I. "L"	7,100	13,905	20,440	26,715	32,715	38,470
		A.P.I. "J"	7,765	15,215	22,360	29,225	35,790	42,085
		Imp. plow	8,940	17,520	25,750	33,655	41,210	48,460
5/8	18x7	A.P.I. "N"	4,275	8,375	12,310	16,090	19,700	23,165
		A.P.I. "L"	4,745	9,295	13,665	17,860	21,870	25,715
		A.P.I. "J"	5,215	10,220	15,020	19,630	24,040	28,270
		Imp. plow	6,000	11,755	17,280	22,585	27,655	32,520
3/4		A.P.I. "N"	6,120	11,985	17,615	23,025	28,195	33,155
		A.P.I. "L"	6,785	13,290	19,535	25,535	31,270	36,770
		A.P.I. "J"	7,450	14,600	21,455	28,045	34,340	40,380
		Imp. plow	8,590	16,825	24,730	32,325	39,585	46,545
7/8		A.P.I. "N"	8,275	16,210	23,830	31,145	38,140	44,845
		A.P.I. "L"	9,215	18,055	26,540	34,685	42,475	49,945
		A.P.I. "J"	10,155	19,900	29,250	38,230	46,815	55,045
		Imp. plow	11,685	22,895	33,655	43,985	53,865	63,335
1		A.P.I. "N"	10,705	20,975	30,830	40,295	49,345	58,025
		A.P.I. "L"	11,960	23,435	34,445	45,020	55,130	64,825
		A.P.I. "J"	13,255	25,970	38,170	49,890	61,095	71,840
		Imp. plow	15,215	29,810	43,815	57,270	70,130	82,465

[1]Safety factor of 5 used.

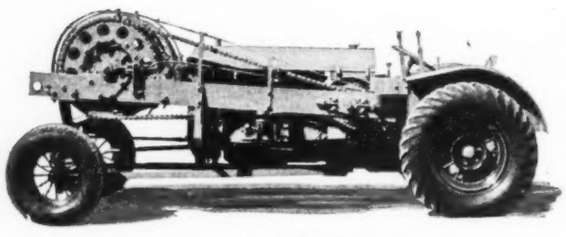
SPECIFICATIONS
ALLIS-CHALMERS WINCH TRACTORS

MODEL	L	UE	UM	W
MAXIMUM LINE PULL	70,000 lbs.	54,032 lbs.	30,250 lbs.	20,000 lbs.
LINE CAPACITIES 1/2-in. line 7/8-in. line	 39,300 ft. 13,600 ft.	 9,800 ft. 3,170 ft.	 8,435 ft. 2,670 ft.	 5,700 ft. 1,840 ft.
LINE SPEEDS	8 speeds 59.2' to 974' p.m.	8 speeds 49' to 1,133' p.m.	8 speeds 49' to 1,133' p.m.	8 speeds 54' to 628' p.m.
DRUM MOUNTINGS	Ball Bearing	Ball Bearing	Ball Bearing	Ball Bearing
ENGINE	6 cylinder	4 cylinder	4 cylinder	4 cylinder
CU. IN. DISPLACEMENT	844	510	318	201
TORQUE	550 ft. lbs.	340 ft. lbs.	200 ft. lbs.	128 ft. lbs.
VALVE ARRANGEM'T	In Head	In Head	In Head	In Head
NUMBER MAIN BEARINGS	4	3	3	3
TOTAL AREA MAIN BEARING SURFACE	157.8 sq. in.	110.7 sq. in.	62.8 sq. in.	41.2 sq. in.
ROAD SPEED	10 m.p.h.	15 or 30 m.p.h.	15 or 30 m.p.h.	22 m.p.h.
FUEL	gas gasoline Diesel oil	gas gasoline Diesel oil	gas gasoline distillate	gas gasoline
LUBRICATION	force feed	force feed	force feed	force feed
WATER CIRCULATION	pump	pump	pump	pump

All units are equipped with Cooper special designed air-cooled brakes. Rotary or spudding equipment is available for all units. The UE and UM tractors are available with double drums and cleaning out equipment. The UE, UM, and W tractors are available with telescoping mast.



A-C Double Drum Winch Tractor



A-C Model UE Winch Tractor

FRED E. COOPER

Office and Plant — Phone 7191 . . Box 1890
HALE STATION — TULSA, OKLAHOMA
Branch: 9619 S. Main Street, Los Angeles

STRENGTH OF A.P.I. STANDARD AND SUPPLEMENTARY STANDARD CASING

Casing size, in.	Wt., lb. per ft., complete with couplings	Bursting strength, lb. per sq. in. S.F. = 2			Limiting length of string, ft., subject to: Collapse, saltwater, S.F. = 2			Parting, S.F. = 2½		
		Lap weld	Seamless		Lap weld	Seamless		Lap weld	Seamless	
			Grade C	Grade D		Grade C	Grade D		Grade C	Grade D
4¾	16.00	3,516	5,270	6,680	4,708	6,497	8,216	3,915	6,174	7,663
4¾ ups	16.25		5,270	6,680		6,497	8,216		9,353	11,976
5¾	14.00	2,000	3,000	3,800	2,081	2,872	3,631	3,674	5,794	7,179
5¾	17.00	2,430	3,650	4,630	2,834	3,912	4,946	3,650	5,756	7,133
5¾	19.50	2,870	4,300	5,450	3,588	4,952	6,261	3,716	5,860	7,262
5¾ ups	20.00	2,870	4,300	5,450		4,952	6,261		9,215	11,800
5¾	22.50	3,300	4,960	6,280	4,342	5,992	7,576	3,674	5,794	7,180
5¾ ups	23.00	3,300	4,960	6,280		5,992	7,576		9,142	11,707
6⅝	20.00	2,170	3,260	4,130	2,382	3,287	4,156	3,697	5,642	6,984
6⅝	24.00	2,660	3,990	5,050	3,219	4,442	5,617	3,727	5,688	7,041
6⅝	26.00	2,910	4,360	5,520	3,651	5,038	6,370	3,744	5,713	7,071
6⅝	28.00	3,150	4,720	5,980	4,069	5,616	7,101	3,746	5,716	7,076
7	20.00	1,940	2,910	3,690	1,982	2,735	3,458	3,647	5,563	6,882
7	22.00	2,150	3,230	4,090	2,341	3,230	4,085	3,653	5,572	6,893
7	24.00	2,370	3,560	4,500	2,725	3,760	4,754	3,677	5,608	6,937
7	26.00	2,590	3,880	4,910	3,096	4,273	5,403	3,684	5,619	6,951
7	28.00	2,810	4,210	5,330	3,480	4,802	6,072	3,696	5,638	6,975
7	30.00	3,020	4,530	5,740	3,851	5,315	6,721	3,697	5,638	6,975
7⅝	26.40	2,150	3,230	4,090	2,342	3,232	4,087	3,555	5,418	6,699
7⅝	29.70	2,460	3,690	4,670	2,876	3,970	5,019	3,589	5,471	6,764
7⅝	33.70	2,820	4,230	5,360	3,502	4,832	6,110	3,599	5,487	6,784
8⅛	28.00	1,970	2,950	3,740	2,027	2,798	3,538	3,381	5,239	6,473
8⅛	32.00	2,280	3,420	4,330	2,561	3,534	4,469	3,398	5,267	6,507
8⅛	35.50	2,580	3,880	4,910	3,094	4,270	5,399	3,455	5,354	6,615
8⅛	39.50	2,890	4,340	5,500	3,628	5,006	6,330	3,452	5,350	6,610
8⅛ ups	40.00	2,890	4,340	5,500		5,006	6,330		9,268	11,868
8⅝	28.00	1,760	2,640	3,350	1,669	2,303	2,912	3,365	5,120	6,437
8⅝	32.00	2,040	3,060	3,880	2,151	2,969	3,754	3,390	5,158	6,484
8⅝	36.00	2,320	3,480	4,400	2,633	3,634	4,595	3,404	5,179	6,512
8⅝	38.00	2,460	3,700	4,680	2,885	3,981	5,034	3,416	5,198	6,535
8⅝	43.00	2,820	4,230	5,360	3,508	4,841	6,121	3,433	5,224	6,567
9	34.00	1,970	2,960	3,750	2,033	2,805	3,547	3,303	5,023	6,312
9	38.00	2,230	3,350	4,240	2,485	3,430	4,337	3,328	5,061	6,361
9	40.00	2,360	3,540	4,490	2,707	3,735	4,723	3,334	5,070	6,371
9	45.00	2,690	4,030	5,110	3,275	4,519	5,715	3,352	5,097	6,405
9⅝	36.00	1,830	2,740	3,470	1,784	2,461	3,112	3,199	4,952	6,221
9⅝	40.00	2,050	3,080	3,900	2,171	2,996	3,788	3,216	4,978	6,254
9⅝	43.50	2,260	3,390	4,290	2,531	3,493	4,417	3,243	5,019	6,305
10¾	40.50	1,630	2,440	3,090	1,436	1,981	2,505	3,054	4,631	5,811
10¾	45.50	1,860	2,790	3,530	1,839	2,538	3,209	3,092	4,688	5,883
10¾	51.00	2,090	3,140	3,980	2,242	3,094	3,912	3,088	4,682	5,876
10¾	55.50	2,300	3,450	4,370	2,605	3,595	4,545	3,108	4,712	5,913
11¾	47.00	1,600	2,390	3,030	1,380	1,904	2,408	2,906	4,489	5,628
11¾	54.00	1,850	2,780	3,520	1,823	2,515	3,180	2,919	4,508	5,653
11¾	60.00	2,080	3,120	3,950	2,221	3,065	3,876	2,939	4,539	5,692
13⅜	48.00	1,230	1,850	2,340	752	1,038	1,313	2,637	4,066	5,088
13⅜	54.50	1,420	2,130	2,700	1,076	1,485	1,878	2,664	4,108	5,141
13⅜	61.00	1,610	2,410	3,050	1,400	1,933	2,444	2,683	4,137	5,177
13⅜	68.00	1,790	2,690	3,410	1,724	2,380	3,009	2,677	4,127	5,164
16	55.00	980	1,460	1,860	374	516	653	2,388	3,766	4,822
16	65.00	1,170	1,760	2,230	645	891	1,126	2,415	3,808	4,877
16	75.00	1,370	2,050	2,600	984	1,358	1,717	2,432	3,835	4,911
16	84.00	1,540	2,320	2,940	1,295	1,788	2,260	2,448	3,860	4,943
18⅝	78.00	1,030			443			2,353		
18⅝	87.50	1,170			638			2,364		
18⅝	96.50	1,300			871			2,383		
21½	92.50	920			311			2,297		
21½	103.00	1,030			445			2,318		
21½	114.00	1,150			609			2,324		
24½	100.50	770			180			2,176		
24½	113.00	870			262			2,189		

Where no data are given, casing is not made in that grade and weight.

the new **REED DK**

ROLLER BIT *with the*

COMBINATION BALL THRUST AND ROLLER BEARING ASSEMBLY KEEPS CUTTERS IN TRUE ALIGNMENT FOR

INCREASED CUTTING SPEEDS AND MORE HOLE PER BIT

with GREATER SAFETY

THE REED DK-1

A general purpose bit especially adapted to drilling broken formations such as: alternate hard and soft layers of strata; shales; limestones; chalks, etc.

The REED DK 3
For cutting hard, well cemented sandstones; very hard limestones; etc.

THE REED DK-2

For hard and tough formations such as: hard shales and harder formations than those on which the DK-1 Bit is generally used.

REED ROLLER BIT CO.

LOS ANGELES HOUSTON OKLAHOMA CITY NEW YORK

Distributed through Supply Companies Everywhere

Mid-Continent and Gulf Coast Distributors for MARTIN-DECKER PRODUCTS

PISTON DISPLACEMENT (CU. IN.) AND RATED HORSEPOWER FOR 4-CYLINDER MOTORS; FOR 8-CYLINDER MOTORS MULTIPLY GIVEN DISPLACEMENT BY 2

Cylinder bore, in.	Stroke, in.																														S.A.E. rating, HP.
	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞	4	4⅛	4¼	4⅜	4½	4⅝	4¾	4⅞	5	5⅛	5¼	5⅜	5½	5⅝	5¾	5⅞	6	6¼	6½	6¾	7	7¼	7½	7¾	8	
2½	59	61	64	66	69	71	74	76	79	81	83	86	88	91	93	96	98	101	103	106	108	110	113	115	118	123	128	132	138	142	148	152	157	10.0
2⅝	65	68	70	73	76	79	81	84	87	89	92	95	97	100	102	106	108	111	114	116	119	122	124	127	130	135	140	146	152	157	162	168	173	11.06
2¾	71	74	77	80	83	86	89	92	95	98	101	104	107	110	113	116	119	122	125	128	131	134	137	140	143	148	154	160	166	172	178	184	190	12.1
2⅞	78	81	84	88	91	94	97	101	104	107	110	114	117	120	123	126	130	133	136	140	143	146	149	152	156	162	169	175	182	188	195	201	208	13.2
3	85	89	92	95	99	103	106	110	113	117	120	124	127	131	134	138	141	145	148	152	156	159	163	166	170	177	184	191	198	205	212	219	226	14.6
3⅛	92	96	100	104	107	111	115	119	123	127	130	134	138	142	146	150	153	157	161	165	169	173	176	180	184	192	199	207	214	222	230	238	245	15.67
3¼	100	104	108	112	116	120	124	129	133	137	141	145	149	153	158	162	166	170	174	178	183	187	191	195	199	207	216	224	232	240	249	257	265	16.9
3⅜	107	112	116	121	125	130	134	139	143	148	152	157	161	165	170	175	179	183	188	192	197	201	206	210	215	224	233	242	251	260	268	277	286	18.25
3½	115	120	125	130	135	140	144	149	154	159	164	168	173	178	183	188	192	197	202	207	212	217	221	226	231	241	250	260	269	279	289	298	308	19.6
3⅝	124	129	134	139	145	150	155	160	165	170	176	181	186	191	195	201	206	211	217	222	227	232	237	243	248	258	268	279	289	299	310	320	330	21.0
3¾	133	138	144	149	156	160	166	171	177	182	188	193	199	204	210	215	221	226	232	237	243	249	254	260	265	276	287	298	309	320	331	342	353	22.5
3⅞	142	147	153	159	165	171	177	183	189	195	200	206	212	218	224	229	236	242	248	253	260	265	271	277	283	295	307	318	330	342	354	366	377	24.0
4	151	157	163	170	176	182	189	195	201	207	214	220	226	233	239	245	251	258	264	270	277	283	289	295	302	314	327	339	352	364	377	390	402	25.6
4⅛	160	167	174	180	187	194	201	207	214	221	227	234	241	247	254	261	267	274	281	287	294	301	307	314	321	334	348	361	374	388	401	414	428	27.2
4¼	170	177	184	191	199	206	213	220	227	234	241	248	255	262	269	277	284	291	298	305	312	319	326	333	340	355	369	383	397	411	426	440	454	28.9
4⅜	180	188	195	203	211	218	226	233	241	248	256	263	271	278	286	293	301	308	316	323	331	338	346	353	361	376	391	406	421	436	451	466	481	30.6
4½	191	199	207	215	223	231	239	247	255	262	270	278	286	294	302	310	318	326	334	342	350	358	366	374	382	398	414	429	445	461	477	493	509	32.4
4⅝	202	210	218	227	235	244	252	260	269	277	286	294	302	311	319	328	336	344	353	361	370	378	386	395	403	420	437	454	470	487	504	521	538	34.2
4¾	213	222	230	239	248	257	266	275	284	292	301	310	319	328	337	346	354	363	372	381	390	399	408	416	425	443	461	478	496	514	532	549	567	36.1
4⅞	224	233	243	252	261	271	280	289	299	308	317	327	336	345	355	364	373	383	392	401	411	420	429	439	448	467	485	504	523	541	560	579	597	38.0
5	236	245	255	265	275	285	295	304	314	324	334	344	353	363	373	383	393	403	412	422	432	442	452	461	471	491	511	530	550	569	589	609	628	40.0
5⅛	248	258	268	279	289	299	309	320	330	340	351	361	371	382	392	402	413	423	433	444	454	464	475	485	495	516	536	557	578	598	619	640	660	42.0
5¼	260	271	281	292	303	314	325	336	346	357	368	379	390	400	411	422	432	444	455	466	476	487	498	509	520	541	563	584	606	628	649	671	693	44.1
5⅜	272	284	295	306	318	329	340	352	363	374	386	397	409	420	431	443	454	465	477	488	499	511	522	533	545	567	590	613	635	658	681	703	726	46.2
5½	285	297	309	321	333	345	356	368	380	393	404	416	428	440	451	463	475	487	499	511	523	535	546	558	570	594	618	641	665	689	713	736	760	48.4
5⅝	298	311	323	336	348	360	373	385	398	410	422	435	447	460	472	485	497	509	522	534	547	559	572	584	596	621	646	671	696	721	746	770	795	50.6
5¾	312	325	338	351	364	377	390	403	416	429	441	454	467	480	494	506	519	532	545	558	571	583	597	610	623	649	675	701	727	753	779	805	831	52.8
5⅞	325	339	352	366	380	393	407	420	434	448	461	474	488	502	515	529	540	556	569	583	596	610	623	637	651	678	705	732	759	786	813	840	867	55.1
6	339	354	368	382	396	410	424	438	452	467	481	495	509	523	537	551	566	580	594	608	622	636	650	664	679	707	735	763	792	820	848	876	905	57.6
6¼	368	384	399	414	430	445	460	476	491	506	522	537	552	568	583	598	614	629	644	660	675	690	706	721	736	767	798	828	859	890	920	951	982	62.5
6½	398	415	431	448	465	481	498	514	531	548	564	581	597	614	630	647	664	680	697	713	730	747	763	780	796	829	863	896	929	962	995	1029	1062	67.5
6¾	429	447	465	483	501	519	537	555	573	590	608	626	644	662	680	698	716	734	752	769	787	805	823	841	859	895	930	966	1002	1038	1074	1109	1145	72.7
7	462	481	500	520	540	559	578	597	616	635	653	672	692	711	731	750	770	789	809	828	847	867	886	904	923	962	1001	1040	1079	1118	1156	1194	1232	78.4
7¼	495	516	537	558	579	599	620	640	661	681	702	723	743	768	785	806	827	848	868	889	910	930	950	970	991	1016	1067	1118	1159	1199	1240	1280	1321	84.1
7½	530	552	574	597	619	640	662	685	707	729	750	772	795	818	840	862	884	908	929	950	972	994	1017	1040	1060	1104	1153	1196	1240	1283	1326	1372	1418	89.9
7¾	566	590	613	636	660	683	707	730	754	778	801	825	849	873	897	920	943	968	990	1017	1039	1062	1084	1107	1132	1179	1224	1272	1320	1368	1414	1460	1506	96.1
Factor "A"	.500	.521	.542	.563	.583	.604	.625	.646	.667	.688	.708	.729	.750	.771	.792	.813	.833	.854	.875	.896	.917	.938	.958	.979	1.000	1.042	1.083	1.125	1.167	1.208	1.250	1.292	1.333	

S. A. E. horsepower rating is based on 1000 feet per minute piston speed. To find equivalent horsepower at 1000 revolutions per minute, multiply S. A. E. rating, for given bore, by factor "A" for given stroke.

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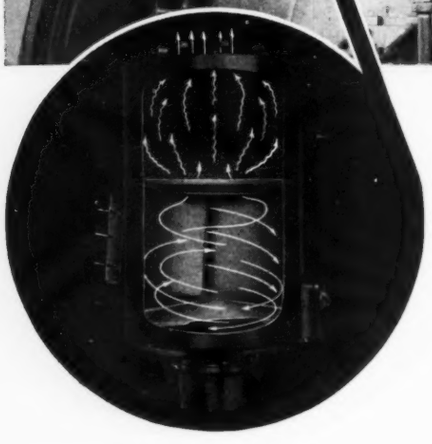


are in tune with the job *always!*

AIR CLEANERS are vital pieces of equipment. To give maximum protection over the entire speed range, they should be accurately fitted to the job ... and Vortox engineers do just that! When you buy a Vortox Air Cleaner, the number of cylinders, the bore, stroke, speed and power of the engine (Diesel, gasoline or natural gas) on which it will be used, are essential points given consideration by Vortox engineers in making recommendations. When the procedure is followed carefully, the Cleaner is absolutely right for the job from the start!

But that's only the beginning ... here's the important performance advantage you get in Vortox, and Vortox only! The Vortox Air Cleaner STAYS TUNED to the job THROUGHOUT ITS LONG LIFE. There are no cloth filters to become dust-clogged and constantly less efficient, and the incoming air does not pass through already dust-laden felts or moss. ALL of the dust trapped in the Vortox Cleaner settles in oil and is trapped below a baffle plate which positively prevents it from again contacting the incoming air.

Here's the Vortox "Triple-Action" cleaning principle. Note its fool-proof efficiency.

1. The air enters the cleaner at a tangent and by its own velocity sets up a miniature cyclone that throws out the heavy dust particles.
2. It then passes through an oil bath where a thorough scrubbing removes fine dust particles.
3. Finally a crimped wire filter gives the air a final cleaning and removes all oil before it is delivered dust-free to the cylinders of the engine.

There are no moving parts in a Vortox Cleaner, nothing to wear out and nothing to replace. The only maintenance required is a cleaning of the dirt sump and a refilling with light oil at regular intervals.

And, remember this—in every Vortox Air Cleaner you get the EXTRA DIVIDEND of efficient air intake silencing, yet this added value costs nothing extra!

The tables on the opposite and preceding pages give vital information needed in selecting an air cleaner. Vortox Engineers use these tables regularly when making recommendations.

VORTOX MFG. CO. ... CLAREMONT, CALIF.

VORTOX OIL TYPE SELF-WASHING **AIR CLEANER**

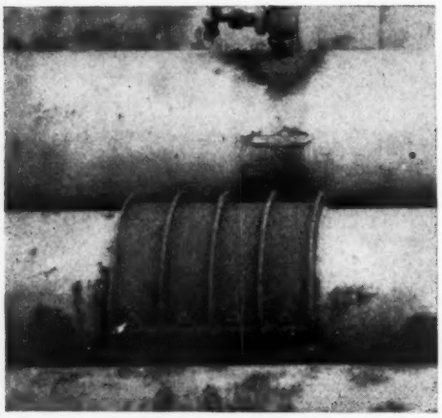
PRESSURE DROP, LB. PER SQ. IN. PER MILE OF 8-in.[1] PIPE LINE (Oil of 40° A.P.I.)

Quantity of 40° A.P.I. oil, bbl. per hr.	Viscosity of oil, Saybolt Universal seconds										
	50	60	70	80	90	100	110	120	130	140	150
350	3.39	3.67	3.91	4.09	4.26	4.43	4.56	4.68	4.78	4.88	4.98
360	3.57	3.86	4.11	4.31	4.48	4.66	4.80	4.92	5.03	5.14	5.24
370	3.75	4.05	4.31	4.52	4.71	4.89	5.04	5.16	5.28	5.40	5.50
380	3.93	4.25	4.52	4.74	4.94	5.13	5.29	5.42	5.54	5.66	5.77
390	4.12	4.45	4.74	4.97	5.18	5.38	5.54	5.68	5.80	5.93	6.04
400	4.31	4.65	4.95	5.20	5.42	5.63	5.80	5.95	6.07	6.20	6.32
410	4.51	4.86	5.17	5.43	5.66	5.88	6.06	6.21	6.35	6.48	6.60
420	4.71	5.07	5.40	5.66	5.90	6.14	6.33	6.49	6.62	6.76	6.89
430	4.91	5.29	5.63	5.90	6.15	6.40	6.60	6.77	6.91	7.05	7.18
440	5.11	5.50	5.86	6.14	6.40	6.65	6.86	7.04	7.19	7.34	7.47
450	5.32	5.72	6.10	6.39	6.66	6.92	7.14	7.32	7.48	7.64	7.78
460	5.53	5.94	6.34	6.65	6.92	7.19	7.42	7.61	7.78	7.94	8.09
470	5.75	6.18	6.58	6.90	7.19	7.47	7.70	7.90	8.08	8.25	8.40
480	5.96	6.41	6.83	7.16	7.46	7.76	7.99	8.20	8.38	8.56	8.72
490	6.19	6.65	7.08	7.43	7.74	8.05	8.29	8.51	8.69	8.87	9.04
500	6.41	6.90	7.34	7.69	8.02	8.34	8.59	8.82	9.00	9.19	9.36
510	6.63	7.14	7.60	7.96	8.30	8.63	8.90	9.13	9.32	9.51	9.69
520	6.86	7.39	7.87	8.24	8.59	8.93	9.29	9.45	9.64	9.84	10.02
530	7.09	7.64	8.14	8.52	8.88	9.23	9.52	9.77	9.97	10.17	10.36
540	7.32	7.89	8.40	8.80	9.16	9.53	9.82	10.09	10.30	10.50	10.69
550	7.55	8.14	8.68	9.09	9.46	9.84	10.14	10.42	10.64	10.84	11.03
560	7.80	8.40	8.95	9.38	9.77	10.15	10.47	10.75	10.98	11.19	11.38
570	8.05	8.66	9.24	9.68	10.08	10.46	10.79	11.09	11.32	11.54	11.74
580	8.30	8.93	9.52	9.98	10.40	10.79	11.12	11.43	11.67	11.90	12.10
590	8.56	9.19	9.81	10.28	10.71	11.12	11.45	11.77	12.02	12.25	12.47
600	8.82	9.46	10.10	10.59	11.03	11.46	11.80	12.11	12.37	12.62	12.84
610	9.08	9.73	10.39	10.90	11.36	11.79	12.14	12.47	12.73	12.98	13.21
620	9.34	10.00	10.68	11.21	11.68	12.13	12.50	12.83	13.08	13.35	13.58
630	9.61	10.29	10.98	11.52	12.01	12.48	12.85	13.20	13.46	13.72	13.96
640	9.87	10.57	11.27	11.83	12.33	12.81	13.20	13.56	13.83	14.08	14.33
650	10.14	10.87	11.57	12.15	12.67	13.16	13.56	13.93	14.21	14.47	14.72
660	10.41	11.16	11.87	12.47	13.01	13.52	13.93	14.31	14.59	14.86	15.11
670	10.68	11.46	12.18	12.79	13.34	13.87	14.29	14.69	14.98	15.26	15.51
680	10.96	11.76	12.50	13.11	13.69	14.23	14.67	15.07	15.37	15.66	15.92
690	11.24	12.06	12.82	13.44	14.03	14.59	15.04	15.46	15.77	16.06	16.33
700	11.52	12.37	13.15	13.77	14.38	14.95	15.42	15.85	16.17	16.47	16.74
710	11.81	12.67	13.48	14.10	14.73	15.32	15.80	16.24	16.57	16.88	17.16
720	12.09	12.99	13.81	14.44	15.08	15.69	16.18	16.63	16.97	17.29	17.58
730	12.37	13.29	14.14	14.78	15.42	16.05	16.55	17.02	17.37	17.70	17.99
740	12.66	13.60	14.48	15.14	15.78	16.42	16.94	17.42	17.78	18.11	18.42
750	12.95	13.92	14.82	15.49	16.15	16.79	17.32	17.82	18.19	18.53	18.84
760	13.24	14.24	15.16	15.85	16.53	17.17	17.72	18.22	18.60	18.96	19.28
770	13.53	14.56	15.50	16.22	16.91	17.55	18.11	18.63	19.02	19.38	19.71
780	13.83	14.88	15.85	16.58	17.30	17.95	18.51	19.04	19.44	19.81	20.15
790	14.13	15.20	16.20	16.95	17.68	18.35	18.90	19.45	19.86	20.24	20.59
800	14.42	15.53	16.55	17.32	18.07	18.76	19.32	19.86	20.28	20.68	21.03
810	14.72	15.86	16.90	17.69	18.46	19.17	19.75	20.28	20.71	21.11	21.48
820	15.02	16.19	17.26	18.07	18.86	19.58	20.17	20.72	21.14	21.55	21.92
830	15.34	16.51	17.61	18.44	19.24	19.98	20.59	21.15	21.55	21.98	22.36
840	15.67	16.84	17.96	18.81	19.64	20.40	21.02	21.59	21.99	22.42	22.81
850	16.00	17.17	18.33	19.20	20.04	20.82	21.45	22.04	22.44	22.87	23.27
860	16.33	17.53	18.69	19.58	20.45	21.24	21.89	22.49	22.90	23.31	23.72
870	16.66	17.89	19.05	19.96	20.85	21.67	22.33	22.95	23.37	23.79	24.18
880	17.00	18.26	19.42	20.35	21.26	22.09	22.77	23.40	23.83	24.26	24.66
890	17.34	18.63	19.79	20.74	21.67	22.52	23.22	23.86	24.30	24.74	25.15
900	17.67	18.99	20.18	21.13	22.08	22.95	23.66	24.32	24.77	25.22	25.64
910	18.02	19.37	20.58	21.52	22.49	23.38	24.11	24.79	25.25	25.70	26.14
920	18.36	19.74	20.98	21.92	22.91	23.82	24.56	25.25	25.72	26.19	26.63
930	18.70	20.11	21.37	22.30	23.32	24.25	25.01	25.71	26.19	26.67	27.12
940	19.05	20.48	21.78	22.73	23.73	24.68	25.46	26.18	26.67	27.16	27.62
950	19.39	20.86	22.19	23.16	24.16	25.13	25.92	26.65	27.15	27.65	28.12
960	19.75	21.25	22.60	23.59	24.58	25.57	26.38	27.13	27.64	28.15	28.63
970	20.10	21.63	23.01	24.02	25.00	26.01	26.84	27.61	28.13	28.65	29.14
980	20.45	22.02	23.43	24.46	25.46	26.46	27.30	28.09	28.62	29.15	29.65
990	20.81	22.41	23.84	24.90	25.92	26.91	27.77	28.57	29.11	29.65	30.16
1000	21.17	22.80	24.26	25.34	26.38	27.36	28.24	29.05	29.60	30.16	30.68

[1]25.55 lb. per ft. For 29.35 lb. line pipe the pressure drop is about 4.7% greater.

SKINNER OFFERS A CLAMP FOR EVERY LEAK

Actual photographs show various useful Skinner Clamps in the field — giving safe, lasting protection. Many Skinner clamps have been in use 10 — 20 — 30 years! and more. Universally used in Oil and Gas industries. WRITE FOR COMPLETE CATALOG!

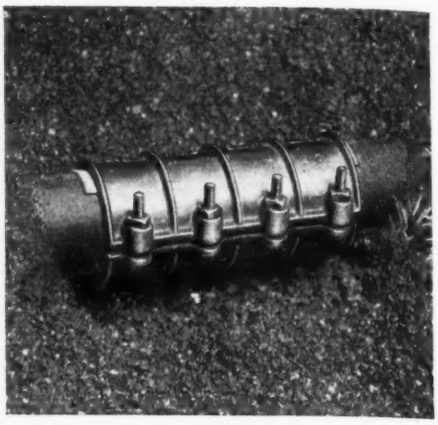


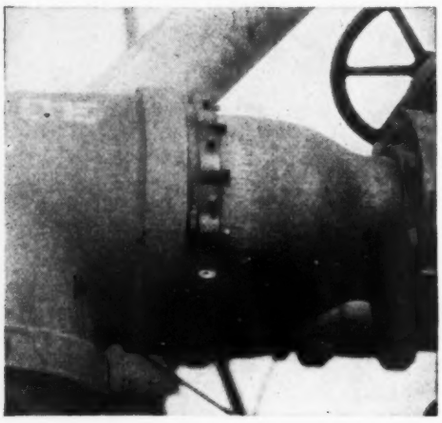
● EMERGENCY PIPE CLAMP

FOR stopping leaks in pipe lines, instantly, permanently. Quickly, easily applied. Pipe sizes ½" to 12". Standard in the petroleum industry for nearly forty years.

PIPE LINE CLAMP ●

FOR repairing long splits or very bad corrosion in pipe lines. Tremendously strong—suitable for highest pressures.



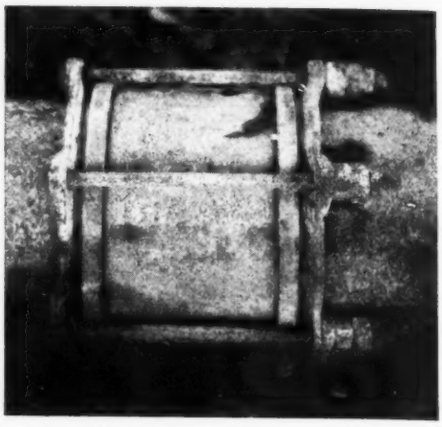


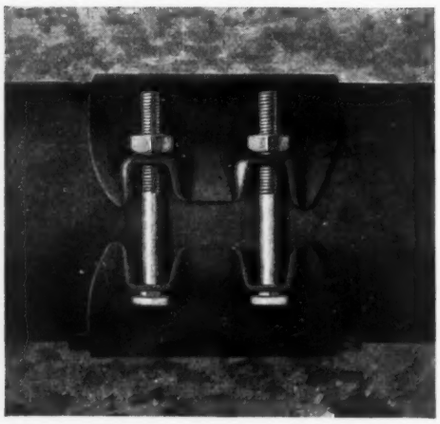
● PIPE JOINT CLAMP

FOR stopping leaks at joints where pipe is screwed into a fitting—any thread leak at tee, elbow, flange, gate coupling, or master gate. Without shutdown. Absolutely permanent.

COLLAR LEAK CLAMP ●

FOR stopping every type of collar leak, regardless of kind of collar used, or condition of line. Rough, tapered, or uneven collars easily clamped.



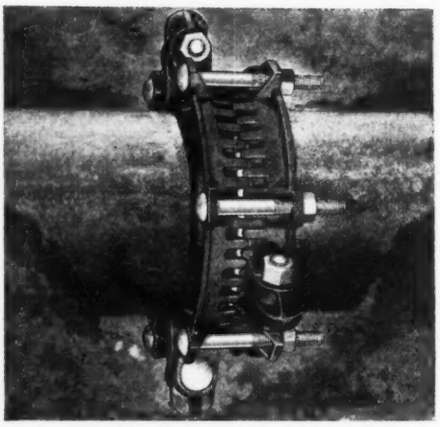


● PRESSED STEEL ECONOMY CLAMP

FOR repairing badly pitted and corroded pipe lines, at a minimum of cost. A strong clamp—sold in quantities for less than the cost of homemade repairs.

HIGH PRESSURE WELD CLAMP ●

FOR stopping pin hole leaks or splits in welds on welded steel pipe lines. A big time-saver. Tested to 800 lbs. line pressure.



M. B. SKINNER CO. *Est. 1898* SOUTH BEND, IND.

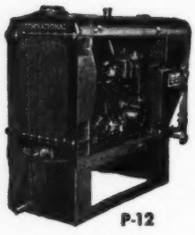
THEORETICAL DISPLACEMENT OF OIL WELL PLUNGER PUMPS, BBL. PER HR.

Speed × Stroke[1]	Plunger diameter, in.												
	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3¾	4¼	4¾
100	.49	.76	1.09	1.49	1.94	2.46	3.04	3.67	4.37	5.13	6.83	8.77	10.96
110	.53	.83	1.20	1.64	2.14	2.70	3.34	4.04	4.81	5.64	7.51	9.65	12.05
120	.58	.91	1.31	1.78	2.33	2.95	3.64	4.41	5.25	6.16	8.20	10.53	13.15
130	.63	.99	1.42	1.93	2.53	3.20	3.95	4.78	5.68	6.67	8.88	11.41	14.25
140	.68	1.06	1.53	2.08	2.72	3.44	4.25	5.14	6.12	7.18	9.56	12.28	15.34
150	.73	1.14	1.64	2.23	2.91	3.69	4.55	5.51	6.56	7.70	10.25	13.16	16.44
160	.78	1.21	1.75	2.38	3.11	3.93	4.86	5.88	6.99	8.21	10.93	14.04	17.53
170	.83	1.29	1.86	2.53	3.30	4.18	5.16	6.24	7.43	8.72	11.61	14.91	18.63
180	.87	1.37	1.97	2.68	3.50	4.43	5.46	6.61	7.87	9.23	12.29	15.79	19.73
190	.92	1.44	2.08	2.83	3.69	4.67	5.77	6.98	8.31	9.75	12.98	16.67	20.82
200	.97	1.52	2.19	2.97	3.89	4.92	6.07	7.35	8.74	10.26	13.66	17.55	21.92
210	1.02	1.59	2.29	3.12	4.08	5.16	6.37	7.71	9.18	10.77	14.34	18.42	23.01
220	1.07	1.67	2.40	3.27	4.27	5.41	6.68	8.08	9.62	11.29	15.03	19.30	24.11
230	1.12	1.75	2.51	3.42	4.47	5.66	6.98	8.45	10.05	11.80	15.71	20.18	25.21
240	1.17	1.82	2.62	3.57	4.66	5.90	7.29	8.82	10.49	12.31	16.39	21.06	26.30
250	1.21	1.90	2.73	3.72	4.86	6.15	7.59	9.18	10.93	12.83	17.08	21.93	27.40
260	1.26	1.97	2.84	3.87	5.05	6.39	7.89	9.55	11.37	13.34	17.76	22.81	28.49
270	1.31	2.05	2.95	4.02	5.25	6.64	8.20	9.92	11.80	13.85	18.44	23.69	29.59
280	1.36	2.13	3.06	4.16	5.44	6.88	8.50	10.28	12.24	14.36	19.12	24.56	30.68
290	1.41	2.20	3.17	4.31	5.63	7.13	8.80	10.65	12.68	14.88	19.81	25.44	31.78
300	1.46	2.28	3.28	4.46	5.83	7.38	9.11	11.02	13.11	15.39	20.49	26.32	32.88
310	1.51	2.35	3.39	4.61	6.02	7.62	9.41	11.39	13.55	15.90	21.17	27.20	33.97
320	1.55	2.43	3.50	4.76	6.22	7.87	9.71	11.75	13.99	16.42	21.86	28.07	35.07
330	1.60	2.50	3.61	4.91	6.41	8.11	10.02	12.12	14.43	16.93	22.54	28.95	36.16
340	1.65	2.58	3.72	5.06	6.61	8.36	10.32	12.49	14.86	17.44	23.22	29.83	37.26
350	1.70	2.66	3.82	5.21	6.80	8.61	10.62	12.86	15.30	17.96	23.91	30.71	38.36
360	1.75	2.73	3.93	5.35	6.99	8.85	10.93	13.22	15.74	18.47	24.59	31.58	39.45
370	1.80	2.81	4.04	5.50	7.19	9.10	11.23	13.59	16.17	18.98	25.27	32.46	40.55
380	1.85	2.88	4.15	5.65	7.38	9.34	11.54	13.96	16.61	19.50	25.96	33.34	41.64
390	1.89	2.96	4.26	5.80	7.58	9.59	11.84	14.33	17.05	20.01	26.64	34.22	42.74
400	1.94	3.04	4.37	5.95	7.77	9.84	12.14	14.69	17.49	20.52	27.32	35.09	43.84
410	1.99	3.11	4.48	6.10	7.97	10.08	12.45	15.06	17.92	21.03	28.00	35.97	44.93
420	2.04	3.19	4.59	6.25	8.16	10.33	12.75	15.43	18.36	21.55	28.69	36.85	46.03
430	2.09	3.26	4.70	6.40	8.35	10.57	13.05	15.79	18.80	22.06	29.37	37.72	47.12
440	2.14	3.34	4.81	6.54	8.55	10.82	13.36	16.16	19.23	22.57	30.05	38.60	48.22
450	2.19	3.42	4.92	6.69	8.74	11.07	13.66	16.53	19.67	23.09	30.74	39.48	49.32
460	2.23	3.49	5.03	6.84	8.94	11.31	13.96	16.90	20.11	23.60	31.42	40.36	50.41
470	2.28	3.57	5.14	6.99	9.13	11.56	14.27	17.26	20.55	24.11	32.10	41.23	51.51
480	2.33	3.64	5.25	7.14	9.33	11.80	14.57	17.63	20.98	24.63	32.79	42.11	52.60
490	2.38	3.72	5.35	7.29	9.52	12.05	14.87	18.00	21.42	25.14	33.47	42.99	53.70
500	2.43	3.79	5.46	7.44	9.71	12.29	15.18	18.37	21.86	25.65	34.15	43.87	54.79
510	2.48	3.87	5.57	7.59	9.91	12.54	15.48	18.73	22.29	26.16	34.83	44.74	55.89
520	2.53	3.95	5.68	7.73	10.10	12.79	15.79	19.10	22.73	26.68	35.52	45.62	56.99
530	2.57	4.02	5.79	7.88	10.30	13.03	16.09	19.47	23.17	27.19	36.20	46.50	58.08
540	2.62	4.10	5.90	8.03	10.49	13.28	16.39	19.84	23.61	27.70	36.88	47.38	59.18
550	2.67	4.17	6.01	8.18	10.69	13.52	16.70	20.20	24.04	28.22	37.57	48.25	60.27
560	2.72	4.25	6.12	8.33	10.88	13.77	17.00	20.57	24.48	28.73	38.25	49.13	61.37
570	2.77	4.33	6.23	8.48	11.07	14.02	17.30	20.94	24.92	29.24	38.93	50.01	62.47
580	2.82	4.40	6.34	8.63	11.27	14.26	17.61	21.30	25.35	29.76	39.62	50.88	63.56
590	2.87	4.48	6.45	8.78	11.46	14.51	17.91	21.67	25.79	30.27	40.30	51.76	64.66
600	2.91	4.55	6.56	8.92	11.66	14.75	18.21	22.04	26.23	30.78	40.98	52.64	65.75
610	2.96	4.63	6.67	9.07	11.85	15.00	18.52	22.41	26.67	31.30	41.67	53.52	66.85
620	3.01	4.71	6.78	9.22	12.05	15.25	18.82	22.77	27.10	31.81	42.35	54.39	67.95
630	3.06	4.78	6.88	9.37	12.24	15.49	19.12	23.14	27.54	32.32	43.03	55.27	69.04
640	3.11	4.86	6.99	9.52	12.43	15.74	19.43	23.51	27.98	32.83	43.71	56.15	70.14
650	3.16	4.93	7.10	9.67	12.63	15.98	19.73	23.88	28.41	33.35	44.40	57.03	71.23
660	3.21	5.01	7.21	9.82	12.82	16.23	20.04	24.24	28.85	33.86	45.08	57.90	72.33
670	3.25	5.09	7.32	9.97	13.02	16.47	20.34	24.61	29.29	34.37	45.76	58.78	73.42
680	3.30	5.16	7.43	10.11	13.21	16.72	20.64	24.98	29.73	34.89	46.45	59.66	74.52
690	3.35	5.24	7.54	10.26	13.41	16.97	20.95	25.35	30.16	35.40	47.13	60.54	75.62
700	3.40	5.31	7.65	10.41	13.60	17.21	21.25	25.71	30.60	35.91	47.81	61.41	76.71
710	3.45	5.39	7.76	10.56	13.79	17.46	21.55	26.08	31.04	36.43	48.50	62.29	77.81
720	3.50	5.46	7.87	10.71	13.99	17.70	21.86	26.45	31.47	36.94	49.18	63.17	78.90
730	3.55	5.54	7.98	10.86	14.18	17.95	22.16	26.81	31.91	37.45	49.86	64.04	80.00
740	3.59	5.62	8.09	11.01	14.38	18.20	22.46	27.18	32.35	37.96	50.54	64.92	81.10
750	3.64	5.69	8.20	11.16	14.57	18.44	22.77	27.55	32.79	38.48	51.23	65.80	82.19
760	3.69	5.77	8.31	11.30	14.77	18.69	23.07	27.92	33.22	38.99	51.91	66.68	83.29
770	3.74	5.84	8.41	11.45	14.96	18.93	23.37	28.28	33.66	39.50	52.59	67.55	84.38
780	3.79	5.92	8.52	11.60	15.15	19.18	23.68	28.65	34.10	40.02	53.28	68.43	85.48
790	3.84	6.00	8.63	11.75	15.35	19.43	23.98	29.02	34.53	40.53	53.96	69.31	86.58

[1]Length of stroke in inches times number of strokes per minute.
In the footnote on P 531 (Sheet 1) "feet" should read "inches".

INTERNATIONAL ENGINES

Cut Pumping Costs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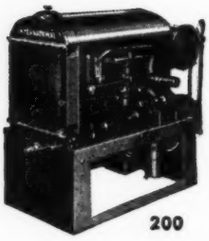
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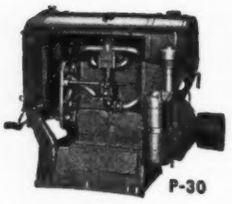
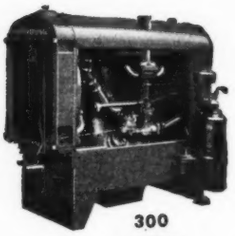

P-30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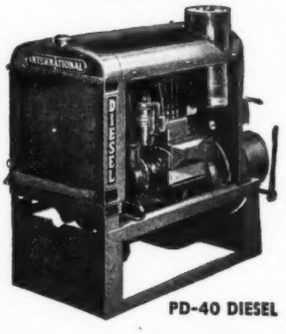
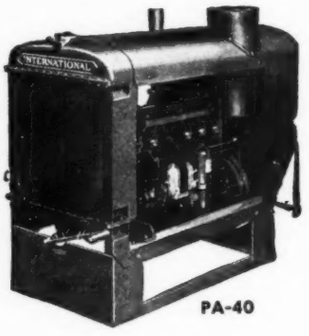

PD-40 DIESEL


PA-40

● These engines are the product of International Harvester, *world's largest tractor builder,* and are backed by this Company's world-wide reputation for *quality* and *after-sale service.* They have seen action in almost every conceivable kind of work and condition throughout the world—thoroughly tried and tested from every standpoint for the gruelling work of powering oil-well pumps.

The *sound engineering* of every detail in International Engines shows up to particular advantage in pumping work. In field after field they have proved their ability to provide a *smooth flow of dependable power* twenty-four hours a day for month after month and year after year.

The *economy* of International Engines is readily apparent in the cost records of their users. And this goes for *economy of maintenance* as well as of operation. They are built to be serviced *fast, easily,* and at *low cost.* And no matter where they work, factory-standard service is always nearby.

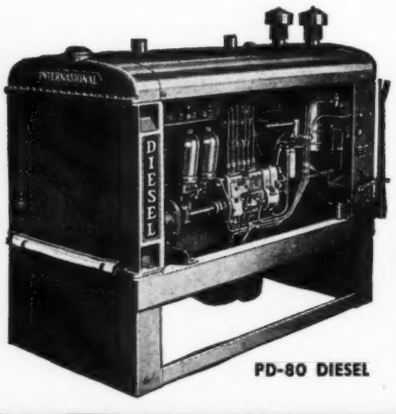
Brief Specifications
INTERNATIONAL POWER UNITS

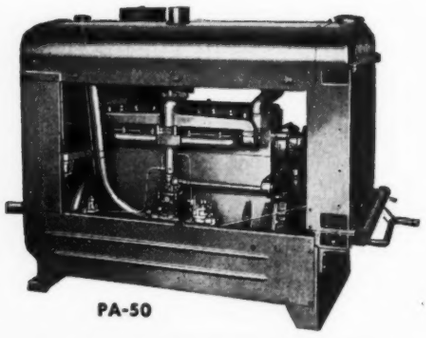
Model	No. Cylinders	Max. Horsepower	Cont. Load Horsepower—80% of Max. H. P.	R. P. M.
P-12	4	22.5	18	1400 to 2000
200	4	33.5	26.8	1000
P-30	4	40	32	1150
300	4	52.5	42	1050
PA-40	6	59.5	47.6	1400 to 1800
PD-40 Diesel	4	62.5	50	1250
PA-50	6	66.5	53.2	1400 to 1800
PD-80 Diesel	6	100	80	1400
PA-100	6	110	88	1400

The International line ranges up to 110 max. h. p. It includes 4 and 6-cylinder engines for gasoline, kerosene, distillate, or natural gas, and 4 and 6-cylinder Diesel engines. They are available in compact power units as shown here; in International Industrial Tractors (wheel and crawler types); and as the power for a variety of equipment built around them. See the nearby industrial power dealer or Company-owned branch for complete information.

INTERNATIONAL HARVESTER COMPANY
(INCORPORATED)
Harvester Building, Chicago, Illinois

PA-100

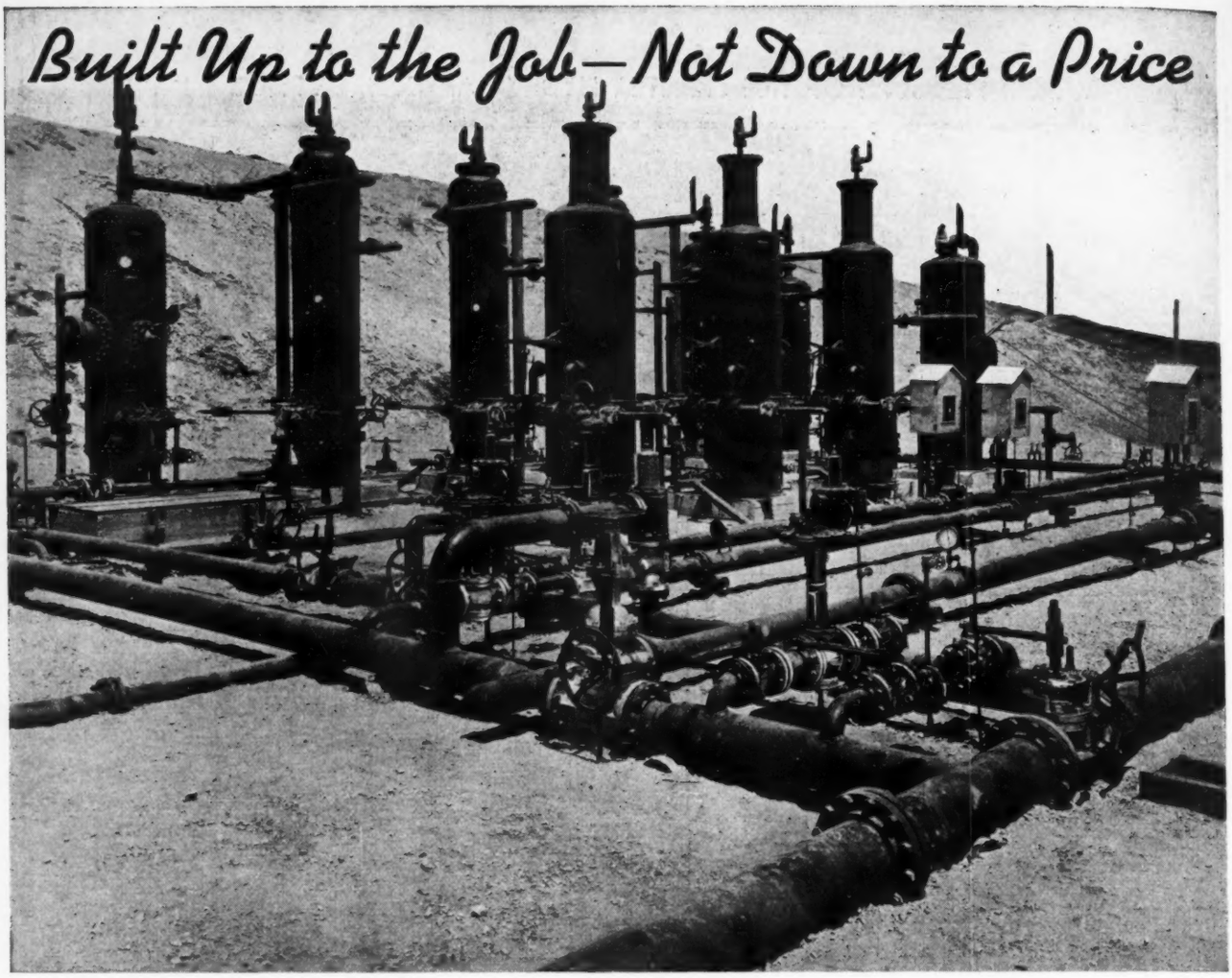

PD-80 DIESEL


PA-50

INTERNATIONAL Industrial Power

VAPOR PRESSURE OF THE LIGHTER HYDROCARBONS, LB. PER SQ. IN.

Temperature, deg. fahr.	Hydrocarbon							Temperature, deg. cent.
	Ethane	Propane	Iso-butane	Butane	Iso-pentane	Pentane	Hexane	
32	348	69.6	25.9	14.9	5.0	3.5	.87	0.0
34	358	71.4	27.1	15.5	5.3	3.7	.92	1.1
36	367	73.3	28.3	16.1	5.6	3.9	.98	2.2
38	377	75.3	29.6	16.7	5.9	4.1	1.04	3.3
40	387	77.4	30.9	17.4	6.2	4.3	1.10	4.4
42		79.6	32.2	18.1	6.5	4.5	1.16	5.6
44		82.0	33.5	18.9	6.8	4.7	1.22	6.7
46		84.5	34.8	19.7	7.1	4.9	1.29	7.8
48		87.1	36.1	20.5	7.4	5.1	1.36	8.9
50		89.8	37.4	21.4	7.7	5.4	1.43	10.0
52		92.7	38.9	22.3	8.0	5.7	1.50	11.1
54		95.8	40.0	23.2	8.3	6.0	1.58	12.2
56		99.0	41.3	24.1	8.6	6.3	1.66	13.3
58		102.2	42.6	25.1	8.9	6.6	1.74	14.4
60		105.5	43.9	26.1	9.2	6.9	1.83	15.6
62		108.9	45.2	27.1	9.6	7.2	1.93	16.7
64		112.4	46.5	28.1	10.0	7.5	2.03	17.8
66		115.9	47.8	29.1	10.4	7.8	2.14	18.9
68		119.4	49.2	30.1	10.8	8.1	2.25	20.0
70		122.9	50.7	31.1	11.2	8.4	2.37	21.1
72		126.4	52.2	32.1	11.6	8.7	2.49	22.2
74		130.0	53.7	33.1	12.1	9.0	2.62	23.3
76		133.6	55.3	34.2	12.6	9.4	2.76	24.4
78		137.3	56.9	35.3	13.1	9.8	2.90	25.6
80		141.1	58.6	36.4	13.7	10.2	3.05	26.7
82		145.0	60.3	37.5	14.3	10.6	3.21	27.8
84		149.0	62.1	38.7	14.8	11.0	3.37	28.9
86		153.1	63.9	39.9	15.5	11.5	3.53	30.0
88		157.3	65.8	41.2	16.2	12.0	3.70	31.1
90	critical temp.	161.5	67.7	42.5	16.9	12.5	3.87	32.2
92		165.8	69.7	43.8	17.6	13.0	4.05	33.3
94		170.2	71.7	45.2	18.3	13.5	4.23	34.4
96		174.7	73.7	46.7	19.0	14.1	4.42	35.6
98		179.2	75.8	48.3	19.7	14.7	4.62	36 7
100		183.7	77.9	49 9	20.4	15.3	4.83	37.8
102		188.3	80.1	51.5	21.1	15.9	5.05	38.9
104		193.0	82.3	53.2	21.8	16.5	5.28	40.0
106		197.8	84.6	55.0	22.6	17.2	5.52	41 1
108		202.7	86.9	56.9	23.4	17.9	5.77	42 2
110		207 7	89.3	58.9	24.3	18.6	6.03	43.3
112		212.7	91.7	61.0	25.2	19.3	6 29	44.4
114		217.8	94.2	63.2	26.1	20.0	6.56	45.6
116		223.0	96.7	65.5	27.1	20.8	6.84	46.7
118		228.3	99.3	67.8	28.1	21.6	7.13	47.8
120		233.7	101.9	70.1	29.2	22.4	7.43	48.9



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Correct design, rugged construction, highest quality materials, precision workmanship and thorough testing insure Masoneilan equipment staying in the line and out of the repair shop.

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